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Photographic Processing Equipment

By JOHN R. TURNER

Conventional methods of photographic processing and the functional elements of processing machines such as drives, recirculation systems and agitation devices are reviewed, particularly as related to motion-picture film. Note is taken of techniques, evolved in related fields, that represent a wide departure from these practices both in simplicity and in speed. Also discussed are some photographic processing methods which have had only limited commercial application but which offer comparable possibilities of increased speed and simplicity.

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PHOTOGRAPHIC processing methods and equipment designs during the past thirty years have been characterized by a general trend of improvement and standardization.

The high quality of present-day color motion pictures is evidence of the technical accomplishments of motion-picture laboratories in color processing. The methods and processing machine designs employed, while generally similar to those previously used for the processing of black-and-white motion-picture films, incorporate additional refinements to meet the more rigorous requirements of color.

Important progress has also occurred in photofinishing operations. Considerable mechanization and a general adoption of continuous strip printing and processing has taken place in most of the larger photofinishing establishments for black-and-white and more recently for color.

On the other hand, in related fields techniques have been evolved that represent a wide departure from established practice, both in simplicity and in speed. The Polaroid*,[1] process is one such example. Other systems, employing magnetic tape and xerography, are displacing photography for some purposes. Where these newer systems are preferred, it is partly because they avoid some of the inconveniences and delays associated with conventional photographic processing.

Simplified, rapid, photographic processing has been applied to a limited extent to meet some special needs. It seems probable that one of the directions in which photography will progress in the future will be toward a more general application of rapid simplified processes where needed to avoid inconveniences and delays.

It is the purpose of this discussion to review the methods and general practices commonly employed in conventional photographic processing, to summarize some of the improvements introduced in recent years, and to attempt to appraise some of the possibilities for future improvement in this field.

Presented on October 20, 1958, at the Society's Convention in Detroit by John R. Turner, Color Technology Div., Eastman Kodak Co., Rochester 4, N.Y.
(This paper was received on January 29, 1959.)

* Polaroid Corp., Cambridge, Mass.

I. DEFINITION — GENERAL ASPECTS

The term *processing* is used in photography to describe the series of chemical and physical treatments applied to sensitized film and paper products to obtain the final photographic image after exposure of the sensitized coating.

These treatments include, in conventional reversal or negative-positive processes: development of silver halide grains to silver; fixation to remove undeveloped silver halide; bleaching to remove unwanted silver image; and washing to discharge from the sensitized coating reaction products and chemicals used in the processing treatments. Drying of the sensitized coating and the support is a normal final stage following wet processing.

Processing equipment consists of elements for holding or conveying the film or paper, and elements to contain the processing solution and to apply it to the sensitized surface to be processed. Control of the physical variables — time, temperature, and agitation — is required to obtain a specified photographic result. Successive treatments must generally be sharply defined in their action. Immediate and thorough application of the treating solution is essential at the beginning of each stage. No appreciable delay should occur between processing treatments. Cross contamination between stages must be controlled and must usually be minimized.

Many chemical solutions used for processing must be protected to some degree from reaction with air or with other materials that will affect their properties. Excessive loss of volatile constituents must be prevented. Operating personnel must be protected from contact with toxic processing chemicals.

The materials of construction of processing equipment must be carefully chosen to avoid unfavorable effects on the processed images or deterioration of the equipment resulting from contact with the solutions.[2,3]

The design of processing equipment and the conditions of its use should afford a high degree of physical cleanli-

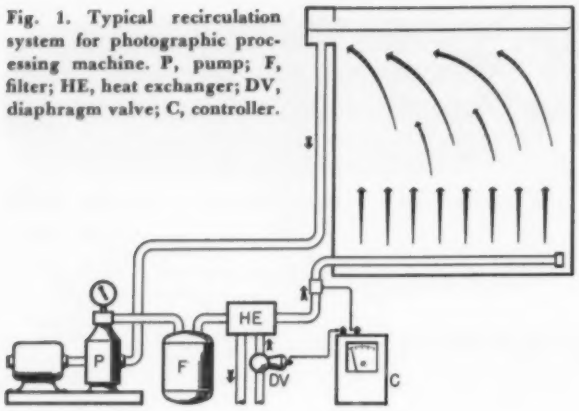

Fig. 1. Typical recirculation system for photographic processing machine. P, pump; F, filter; HE, heat exchanger; DV, diaphragm valve; C, controller.

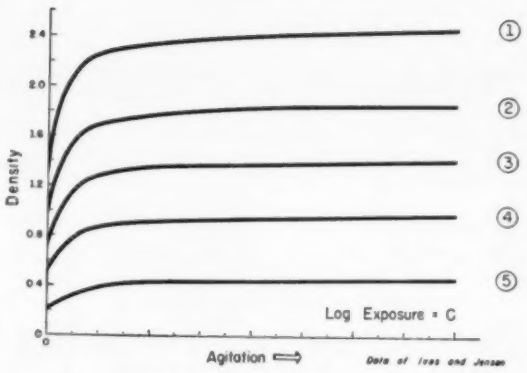

Fig. 2. Effect of agitation on developed density.[5]

ness. The equipment must not cause physical damage to the photographic coating or to the support, except as this may be permissible outside of the picture area, or for specialized uses where critical quality requirements do not apply.

Photographic materials before fulfilling their final use must be processed. The total cost, the commercial acceptability, and the ultimate value of the photographic image to a customer or viewer depend on the efficiency and suitability of the processing. Thus, to a very great extent, commercial demand for a photographic product hinges on the merits or limitations of the associated photographic processing methods and equipment.

II. CLASSICAL PROCESSING

The processing of most photographic materials is carried out by methods and types of equipment that have been in use for an extended period of years. These can be regarded as "the classical methods." A sequence of liquid-immersion treatments is applied at what has been referred to as "the average temperature of British darkrooms." The methods are as follows:

(1) Tray
(2) Rack and tank
(3) Spiral reel and tank
(4) Cylindrical reel and trough
(5) Continuous machine

Processing equipment in each of these categories is usually used in conjunction with some means of agitation to disperse reaction products or other chemicals that diffuse out of the emulsion coatings during processing, and to apply fresh solution to the surface of the coating. Such agitation is important in obtaining uniformity of processing and in avoiding many of the characteristic defects commonly associated with immersion-processing. Examples of such defects are air bells, bromide streaks, adjacency effects, stains, blisters and scum markings.[4,5]

Since immersion-processing of the classical types employs open vessels to contain the various processing solutions during use, such equipment is often wasteful of chemicals both in the oxidation of developers and in the evaporative loss of volatile constituents. Such added chemical usage is often an important cost consideration.

Some people who are dissatisfied with the limitations of conventional processing feel that the industry has not been sufficiently progressive. A paper in the *Journal* in 1956[6] cited as an example of the backwardness of 16mm processing laboratories their failure to adopt spray-processing. More recently spray machines are being installed to an increasing extent.

III. FUNCTIONAL ELEMENTS OF CONVENTIONAL PROCESSING MACHINES

In this discussion of photographic processing equipment some of the general practice used in commercial processing machines will first be reviewed.

A. Processing Vessels

1. Tanks: Processing tanks are designed to be strong and durable and to be readily cleaned. They must not be subject to deterioration as a result of contact with the intended processing solutions, nor tend to affect the chemical properties of the solutions. Tank-overflows are designed to carry off scum. Types 304 and 316 stainless-steel sheets, formed and welded, are generally preferred for tank construction, except for some bleach tanks. Ferricyanide bleach tanks are sometimes made of red brass. A preferred construction is mild steel, lined and covered with polyvinyl chloride, epoxy, polyester, neoprene, rubber, or other materials suitably resistant to the corrosive action of the bleaches. Some tanks with plastic outer surfaces have a supporting structure of Fiberglas or marine plywood.[7] Others are made up of rigid polyvinyl chloride sheets, formed and welded.

2. Spray Cabinets: Light-gage Type 316 stainless steel is generally preferred for spray-processing cabinets. Some spray machines do not provide adequately tight seals on the access doors. Inflatable rubber or neoprene gaskets are particularly effective for this purpose. Compression seals are commonly employed.

B. Recirculation Systems

Solution recirculation systems are used on photographic processing machines for four specific purposes:

(1) to maintain homogeneity of chemical composition in the processing bath;
(2) to control solution temperature;
(3) to agitate the solution; and
(4) to filter the solution.

Typical recirculation systems consist of a pump, filter, heat-exchanger and temperature-controller, and the connecting piping as shown schematically in Fig. 1.

Centrifugal pumps are most commonly used, although turbine pumps may be preferred for high filtration pressures. Pump packings employing liquid seals or mechanical seals are preferred to prevent air-leaks into the pump. A static head on the pump, sufficient to avoid suction on the packing, is desirable. Chempumps,† available for the past few years, incorporate a completely enclosed pump impeller and motor rotor assembly, no packing being required. Vertical-shaft, submerged-impeller pumps also avoid the possibility of air leakage into the pumped solution.

Recirculation filters may be of the replaceable-cartridge type for small flow rates or where relatively little dirt will be accumulated in the filter over a period of time. Cleanable elements or backwashed filters are more economical for larger filtration loads.

Solution filters should preferably remove all particles larger than 20 to 30 microns. Filtration to lower limits than this becomes increasingly more difficult

† Chempump Corp., 1300 East Mermaid Lane, Philadelphia 18.

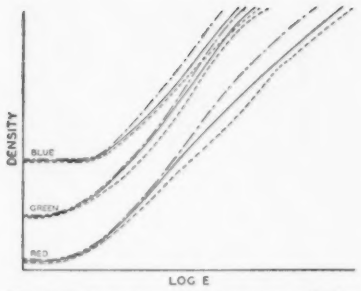

Fig. 3. Effect of over- and under-agitation on developed density of a color motion-picture film (unpublished data of De-Moulin and Weller, Eastman Kodak Co.). ——, over-agitation; ———, normal; – – – –, under-agitation.

and more expensive. On the other hand just a few dirt particles in this size range are likely to be objectionable on a single frame of motion-picture film. Even under these conditions of filtration, processing solutions that tend to generate finely divided sludges may leave objectionable deposits on the film. In the old days of rack-and-tank processing, a change to a fresh mix of developer in the processing tank was immediately apparent to those working in the drying room. The cotton pads used to wipe off water droplets remained clean over a much longer period of use than was the case for the film processed in partially sludged developer. Highly effective squeegeeing before drying is at least a partial answer to the problem of the removal of surface dirt on continuous machines.

Heat-exchangers of the concentric-tube or multiple tube-and-shell types are commonly used for temperature control in conjunction with bulb-and-tube-actuated pneumatic controllers and diaphragm valves.

Piping of thin-wall stainless-steel tubing with welded joints is preferred for large systems because of its cleanliness, strength and lightness. Plastic hose, or rigid polyvinyl chloride tubing with screwed, compression, cemented, or welded joints is used for bleach solutions and more generally for lower pressures and flow rates.[7] Valves of the flexible-diaphragm type have proved to be particularly satisfactory both for durability and for freedom from leakage.

C. Agitation

The effects of agitation in black-and-white processing are comparatively simple, but for multilayer color processes this is less true. It has, however, been an accepted rule in photography that sufficient agitation is a reliable safeguard against many commonly encountered processing difficulties.

The relationship of agitation to developed density for silver images is illustrated by the set of curves in Fig. 2 published by Ives and Jensen[8] in 1943. In these the developed density for each level of exposure is shown, at constant time of development, to increase rapidly as agitation is increased. These curves level off at higher values of agitation to plateaus along which only a slight density change occurs. Along the plateau portion the processing treatment is insensitive to increase in agitation.

A common misconception is that levels of agitation beyond this will have some beneficial effect. Actually once a condition is reached in which normal tank solution is maintained in intimate contact with the emulsion surface, no further photographic effect due to increased hydraulic action will occur. Extremely violent agitation much beyond normal intensities can however produce an increase in temperature beyond normal, thus causing more rapid development to take place.

More complex relationships exist for multilayer color films. Many of these films, designed to be suitable for commercial processing conditions, are of necessity balanced for an aim point associated with an agitation level short of the plateau of the density-agitation curve. At greatly increased or reduced levels of agitation, appreciable between-layer differences of speed, contrast and curve shape may result, as indicated in Fig. 3. The differences here have been slightly exaggerated in order to make them more clearly apparent.

In some recent work, which is not yet completed, we have found that considerably less agitation is actually required in the latter portion of development than is needed initially and while the major growth of density is occurring. Figure 4 shows a graded agitation curve as related to the growth of density. This agitation curve approximates the agitation levels required at various times during the build-up of density to obtain a full agitative effect.

As shown, the agitation required is roughly proportional to the rate of growth of density, the slope of the density growth curve. Thus, by a graded distribution of applied agitation from the available pumps and piping, the quality of development from many processing machines might be considerably improved. This would be accomplished by spacing the submerged jets or spray nozzles closer together for the first portion of development and progressively farther apart in the latter part of the treatment. This principle is stated simply as a generality which will not apply in all cases, as for instance where development is not being carried to completion.

On some immersion processing machines operating at intermediate speeds, the agitation from the motion of the film would be sufficient in the latter part of the treatment. Supplemental agitation would be applied only while the major growth of density is occurring. Other

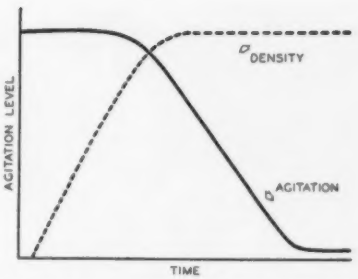

Fig. 4. Approximate agitation level required for full agitative effect. As development rate lessens a smaller amount of agitation is sufficient.

studies in progress have indicated that uniform level of agitation rather than graded agitation is most efficient for wash stages.

Methods of chemical application employing no agitation are also capable of affording uniform treatment. From the limited use that such methods have thus far received, it is apparent that a considerable simplification can be obtained compared to agitated systems. The capabilities and limitations of zero agitation treatments have not been completely evaluated. One conclusion is clear: a little agitation is least likely to be desirable.

In general it can be stated that processing equipment should operate at a controlled level of agitation, designed to produce the desired photographic result at a maximum operational efficiency. For some processing treatments, such as washing or bleaching or other reactions going to completion, it may be more economical to employ a longer time of treatment than to make special provisions for high-level agitation. Some bleaches such as those used for black-and-white reversal processes are an exception in that added time may not compensate entirely for too little agitation.

Methods of agitation commonly used on processing equipment are as follows:

1. Agitation by Motion of the Film Through the Processing Solution: Many large, continuous, immersion machines for the processing of motion-picture film obtain agitation in the saturation region as the result of speeds of film-travel from 100 to 250 ft/min. This is particularly true for "cold" processes (70 F) having low reaction rates. The designations "cold" for 70 F and "hot" for 100 to 150 F used here in reference to processing temperatures are those suggested by Ralph N. Whitmore in his recent paper[9] on spray processing. For very active solutions, or for higher processing temperatures, correspondingly greater agitation is required to reach saturation. Some color films that are processed at low development rates reach saturation at speeds of film-travel as low as 75 ft/min.

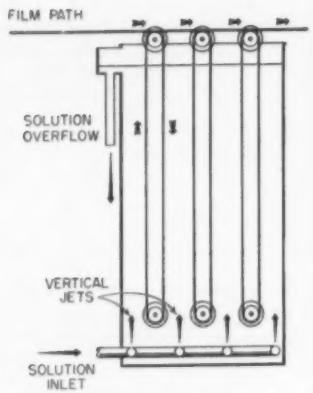

Fig. 5. Turbulation agitation for photographic processing.

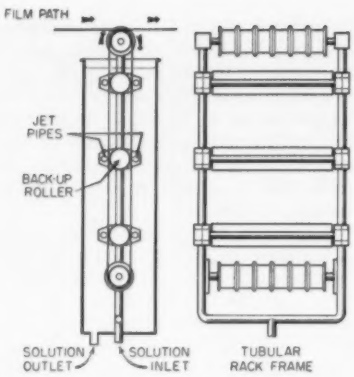

Fig. 6. Submerged jet agitation for motion-picture processing machine.

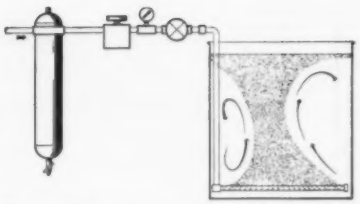

Fig. 7. Continuous gaseous agitation for photographic processing.

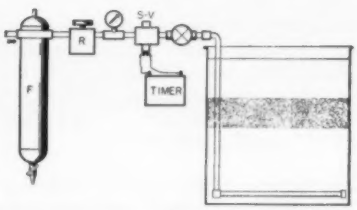

Fig. 8. "Gaseous burst" agitation for photographic processing. F, filter; R, pressure regulator; S-V, solenoid valve.

2. Agitation by "Turbulation": Some color processing machines, operating at speeds of 25 to 50 ft/min, are equipped with horizontal manifolds inside the tanks directly below the film racks as shown in Fig. 5. These manifolds direct jets of recirculated developing solution vertically upward between the film strands. The low-intensity agitative effect of these submerged jets is often referred to as "turbulation."

3. Agitation by Submerged Jets: Many commercial continuous-processing machines, including those used for Eastman Color Films, apply supplemental agitation through submerged jets that apply solution directly to the surface of the film. Figure 6 illustrates a typical design for this purpose. These jet pipes are also sometimes called "turbulators." The pipes are placed perpendicular to the film strands at a distance of usually one-half inch or less. Back-up rollers at the jet impingement points insure that the desired spacing between jet and film surface is maintained. A row of orifices along each jet pipe discharges recirculated solution against the emulsion surface. Since the jet pipes are usually placed at about 1- to 4-sec intervals along the film path, the jet positions are sufficiently random across the film area that there is no apparent streaking on the film as the result of any nonuniform action of an individual row of jets.

4. Agitation by Gas Bubbles: The passage of gas bubbles up through a processing tank is an effective means of agitation.[10] Twenty or more years ago it was common practice to discharge a regulated flow of compressed air at the bottom of the tall narrow tubes often used for processing both black-and-white and color films. Air is seldom used now for developer agitation, partly because of the sensitivity of color developers to oxidation and partly because of the convenient availability of nitrogen at low cost.

Continuous gaseous agitation for tank machines has been to some extent unsatisfactory because eddy currents are generated that sweep the bubbles into a narrow vertical column (Fig. 7). This causes extreme nonuniformity of agitation from top to bottom and from side to side.

Recent practice for low-intensity agitation of developers on continuous machines, or for rack-and-tank development, employs the so-called "nitrogen burst" method. This method, described by Smibert and O'Bern[11] as a result of their work in Australia, consists in the intermittent discharge of nitrogen bubbles uniformly across the bottom of a tank for $\frac{1}{2}$ sec to 2 sec at a controlled rate of discharge. A stratum of bubbles is thus generated (Fig. 8), which passes up through the liquid without channeling into a column. Too thin a stratum will tend to have gaps; too thick a stratum will build up an irregular bottom boundary. An interval of 6 to 60 sec is used between bursts. Too short an interval allows eddy currents to build up. Bubble size, as affected by the size of the outlet orifices and by the gas pressure, is an important factor in the agitative effect. Very small bubbles may rise too slowly. Bubbles that are too large may displace the film too far from its proper position.

Nitrogen agitation is practical both for small operations, for which gas cylinders are a convenient source of supply, and for large operations having a sufficient gas requirement to warrant the installation of a liquid-nitrogen storage vessel.

5. Spray-Application in Gas-Filled Cabinets: Efforts in motion-picture laboratories to eliminate an effect in soundtrack development called "sprocket-hole modulation" led to the introduction by the DeLuxe Laboratories‡ in 1937 of the spray-application of processing solutions to motion-picture film on continuous machines[12] (Fig. 9). No special provisions were made to exclude air or oxygen from the cabinets. Any resulting oxidation of developer was compensated by chemical adjustments and by increased replenishment. These machines succeeded in setting a particularly high standard of photographic quality and uniformity. The process on these machines has been carried out at about 70 F.

The excellent results obtained in "cool" (70 F) spray processes and the high agitation levels obtainable by spray application have led to a recent trend in motion-picture laboratories to "warm" spray processes in the range of 80 to 85 F. At these temperatures black-and-white film is spray-processed in as little as 4 min on machines of the type shown in Fig. 10. The short length of film in the light-sensitive portion of the thread-up permits these machines to be operated as light-tight units; no darkroom is required. Such a small footage of film is contained in the development and rinse stages that little risk of film loss is involved in the event of operating difficulty, which in itself is unlikely.

For some special requirements such as race-track photofinishes and the theater projection of live television programs, black-and-white films have been processed by "hot" spray methods in total times of less than one minute. One early machine[13] employing "hot" spray processing is shown in Fig. 11. Temperatures for such processes range from 120 to 150 F and special chemical solutions are often employed. In the past special prehardening treatments have been used to enable the film to resist "hot" processing temperatures. Many black-and-white films are now sufficiently hardened in manufacture to avoid stripping or reticulation difficulties at these processing temperatures. Thus the way is open for an increasingly broad use of hot spray

‡ DeLuxe Laboratories, Inc., 850 Tenth Ave., New York 19.

Fig. 9. Spray machine for processing motion-picture film at 70 F (DeLuxe Laboratories, Inc.).

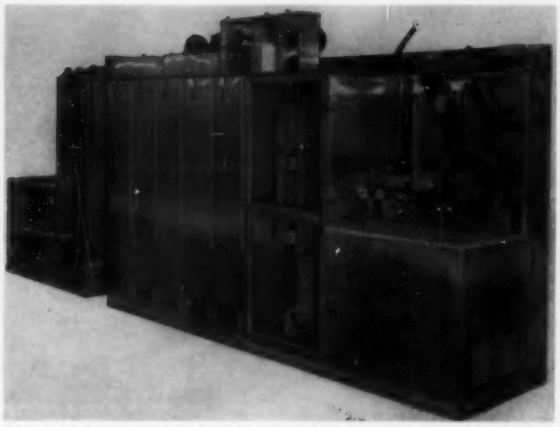

Fig. 10. Spray machine for processing motion-picture film at 80–85 F (Artisan Metal Products, Inc.).

processing as additional film types become suitable for this method of treatment.

Spray application is carried out with commercial spray nozzles, of either the fan or cone types, spaced along the path of the film. Spray pressures are in the range of 7 to 15 lb/sq in. The high-temperature short-time processes require a much more intense spray treatment than low-reaction-rate and low-diffusion-rate processes. The distance between sprays being mainly a time-interval consideration, spacing between sprays for higher speed machines is proportionately greater than for slower machines. It is, therefore, in this respect more economical to build a few large spray machines for a given capacity than to build a large number of small machines.

Developer oxidation, often severe in spray machines, can be prevented entirely by the provision of a nitrogen atmosphere. Actual consumption of nitrogen in such a machine can be negligible, provided that the seals at the doors and at other points provide reasonably tight closures.

6. Kodak X-Omat Multiple Roller Agitation: The Kodak X-Omat Processor utilizes a sequence of positively driven rollers for conveyance and agitation in the processing of x-ray films.[14] These rollers are placed alternately on opposite sides of the film path. The spacing and position of the rollers are chosen so that the film follows a sinuous path. The leading edge of the film is constrained in the desired path by the flat angle of contact as is meets each successive roller. Hence the roller system is entirely self-threading. Machines of the type illustrated in Fig. 12 are now in use in hospitals and medical centers for the processing of x-ray sheet films. The extended waiting time of 30 min, or more, formerly necessary for processing medical x-ray film is reduced to about 6 min through the use of these machines in conjunction with a more rapid process.

7. Ultrasonic Agitation: Ultrasonic agitation for photographic processing is mentioned here only because it has been suggested so many times. Some experimental trials have shown that a large and difficult-to-control rise in temperature occurs when sufficient ultrasonic irradiation is used to obtain cavitation. At the present time it appears that any practical use of this method would be limited to high-temperature processes.

D. Drives for Continuous-Processing Machines

1. Sprocket-Drives for Perforated Film: Some of the first continuous-processing machines for cine film employed sprockets engaging the film perforations to convey the film. These "tube machines," originated by Gaumont, were widely adopted in the industry and at least a few machines of this type are still in use. The film passes over a sprocket at the top of each loop. Weighted idler rollers are suspended at the bottom of each loop. Repair of a film break during operation of these machines is relatively easy.

Later sprocket machines employed pull-through sprockets following as many as eight loops of a helical thread-up of idler rollers. The Duplex machines of this type have been outstanding "work horses" of the industry, even though relatively high film tensions are usual in this pull-through drive. The Duplex design provided ready access for rethreading (Fig. 13). The machine shown here has been modified to provide drive on the top rollers. Somewhat similar machines used at Warner Brothers are constructed to carry each idler roller on an individual bracket and shaft, thus affording even greater ease in rethreading. Most of the processing machines

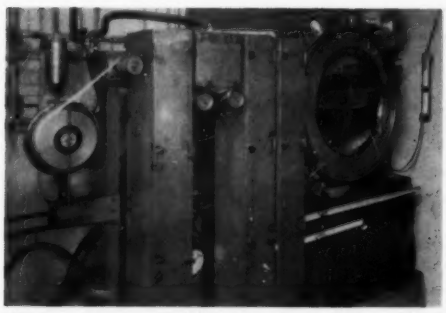

Fig. 11. Spray machine for processing motion-picture film at temperatures of 120 F or more (Ives & Kunz).

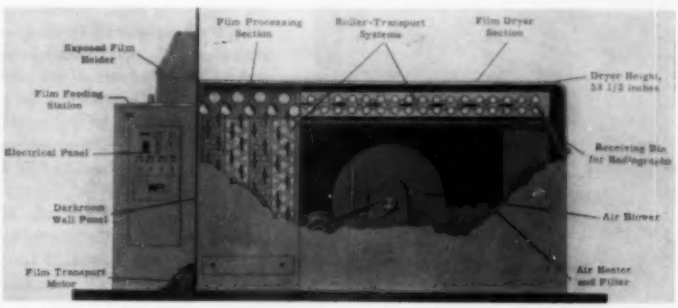

Fig. 12. Kodak X-Omat Processor for x-ray film (Eastman Kodak Co.).

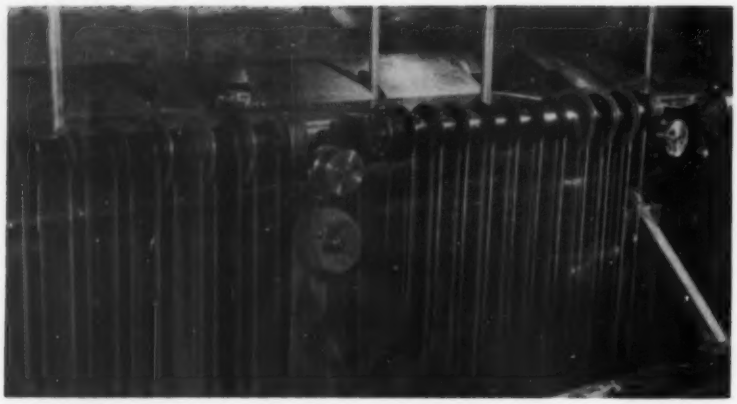

Fig. 13. Duplex machine for processing motion-picture film (Pathé Laboratories, Inc.).

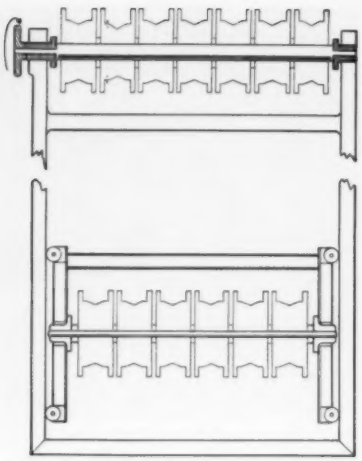

Fig. 14. Typical helical rack for processing motion-picture film.

designed in more recent years are much more difficult to thread but apply a minimum tension to the film so that rethreading is seldom necessary. Minimum tension is not the only requirement for trouble-free operation. Slackness of a loop of film is much more likely to cause operating difficulty than is excess tension.

Film processed on sprocket machines is subject in some degree to damage to the perforations where these bear against the sprocket teeth. For this reason the film is often fed through these machines in such a direction that the position of any minor perforation damage will be away from running contact with the teeth of a printing sprocket, or the claw of a pulldown mechanism.

Most sprocket-type machines currently in use have a single sprocket on the top shaft of helically threaded racks and as many as eight friction-driven rollers on the same shaft, as indicated in Fig. 14. These rollers are made slightly larger in pitch diameter than the sprockets. The top shafts are usually larger in diameter than the shafts carrying the bottom idler rollers in order that the frictional torque on the top, friction-driven rolls will be greater than the resisting torque on the bottom idlers. This differential provides a slight excess of drive thus avoiding the possibility of any slack loops during operation. The bottom idler assemblies are weighted and guided. The weight of these bottom assemblies is supported by the loops of film. As commonly constructed, these machines consist of rack frames fitted with bearings for the top shafts, and with vertical tracks for the bottom floaters. Some machines of this type have no rack frames, the bottom floater in this case being guided within the tank. This construction permits the use of such machines in rooms of lesser height than that required for the rack-frame type.

Fig. 15. Paramount air turbine drive for motion-picture processing machine (General Film Laboratories, Inc.).

2. Tendency-Drive Machines: A drive-system similar to that just described uses a positively driven roller fastened to the shaft in place of the sprocket. These rollers are of about the same pitch diameter as the corresponding sprockets.

The top shaft of each rack is driven at a speed that is controlled by an actuating rod attached to the bottom idler-assembly. The actuating rod may control the speed of the top shaft on the same rack, or preferably is connected to a linkage that regulates the speed of the top shaft on the following rack. Film entering such machines is metered in at constant speed by a positively driven pacer-roller.

Machines of this type installed at Paramount[§] about 1934 used air turbines (Fig. 15) for the controlled drive. Other machines built by Paramount later have used oil turbines instead of air turbines.

The belt-driven machines (Capstaff type) used by Eastman Kodak Co. utilize the controlled slippage of a flat belt making line contact with a driven pulley as in Fig. 16 for the same function as the air or oil turbines. The pressure against the belt of an idler roll, actuated by the floater rod, controls the frictional force applied by the belt to the driven pulley.

The Fonda[‖] drive of more recent design, which is used on some processing machines built by that company, employs a similar principle. However, in this design the controlled slippage is obtained between pairs of friction rollers. The bottom assembly is held in a fixed position and the top floaters are pivoted, and the contact force between the friction rollers is applied by spring tension.

3. Bottom-Drive Machines: A completely different principle for continuous processing machines, bottom-drive, dates back more than thirty years. Some of the original Spoor-Thompson machines of this type continue in routine use in New York City and in Hollywood. These, too, have been "work horses" of the industry. Figure 17 shows a recently built machine of this type.

In contrast to the pacer-position at the feed end of the "tendency-drive" type, bottom-drive machines have a positively

§ Paramount Pictures Corp., 5451 Marathon St., Hollywood 38.

‖ Fonda Corp., 1546 North Argyle Ave., Hollywood 28.

Fig. 16. Belt-drive for motion-picture processing machine (Eastman Kodak Co.).

Fig. 17. Bottom-drive machine for processing motion-picture film — Spoor-Thompson type (DeLuxe Laboratories, Inc.).

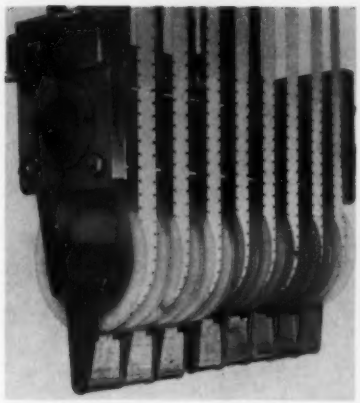

Fig. 18. Experimental weighted loop bottom drive — Van Leuven type.

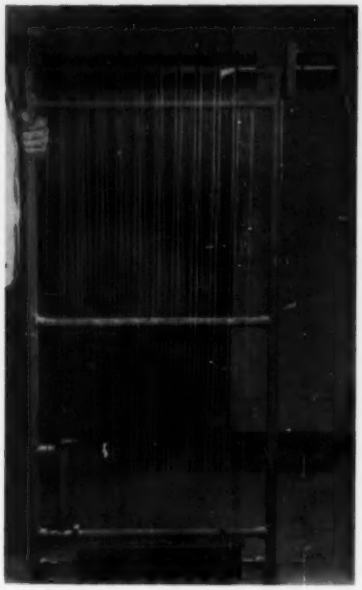

Fig. 19. Torque motor drive for motion-picture film (Moody Institute of Science).

driven pacer-roller just before the final windup. Except for this pacer, or, as users of these machines term it, the "come-along," all film drive is applied by rollers at the bottom of the film loops. These rollers are driven just sufficiently faster than the "come-along" that a slight slippage occurs between the film and these rollers. As an individual loop tends to be driven at an excess speed the film becomes slightly loose against the drive roller. Hence, these machines apply a minimum force to the film, just sufficient to drive it. Some provision must be made on these machines to avoid the effects of swelling and shrinking of the film on uniformity of drive and tension.

The use of submerged-jet or open-spray agitation in machines of this type has presented some difficulty because so little tension exists on the upgoing strands; the only tension is the weight and drag of the film in the strand. A modified bottom drive worked out by Van Leuven[15] about twenty years ago has more recently proved to be particularly satisfactory for use in conjunction with submerged-jet or open-spray agitation. Figure 18 shows an experimental design of this type. This design incorporates pivoted and weighted bottom rollers for each film loop. Increase of tension in any one loop lifts that bottom roller into frictional engagement with a constant-speed drive roller. This combination maintains a sufficient tension that the film resists deflection from its path by sprays or jet pressures.

4. Adjustable-Torque Drive: Some continuous machines provide adjustable-torque elements spaced at sufficient intervals to prevent an excessive accumulation of tension. Such drives are especially suitable for providing an adequate performance at minimum cost.

One machine of this type has an adjustable friction clutch to drive the shaft of each rack. By proper adjustment of each of these clutches a reasonably smooth drive can be maintained within suitable tension limits.

Another machine of special design[16] uses torque motors provided with a voltage control to accomplish the same purpose as the friction clutches on the machines. A rack from this machine, at the Moody Institute of Science, is shown in Fig. 19. This type of drive is not subject to the variations in frictional characteristics that may affect the operation of slippage clutches.

5. Drives for Processing Machines for Paper Prints: One continuous paper processor designed in 1940 was based on the design of a tendency-driven rack. A positively driven holdback was followed by about eight slippage-driven rollers. The shaft and roller diameters were designed to obtain a slight but not excessive buildup of tension from loop to loop, just sufficient to avoid slackness if a less than normal drive friction should occur from time to time.

Other paper processors built some years later have extended the same principle to a much greater number of slippage-driven rollers. Excess buildup of tension through the machine is avoided by the operator who disengages the drive from a few of these rollers through the machine as he finds it necessary.

The design of other later paper processors is a similar effort to obtain simplicity. Sequences of idler rollers at the top and bottom of paper loops are followed by pull-through rollers driven by adjustable-torque motors. The feasibility of tension-regulation within suitable limits on this type of drive depends on maintaining a constant, low bearing-friction on the idler shafts. The use of Teflon-Fiberglas-molybdenum disulfide composition for the bearings in this design provides the needed low and essentially constant frictional characteristic.

E. Squeegees

The necessity for removing surface liquid from sensitized products between some processing stages, and before drying, has led to the use of a number of types of squeegees for this purpose. Some of these are illustrated in Fig. 20.

1. Wiper blades similar in principle to those for windshields are used to some extent for hand-squeegeeing of individual sheets. Such wipers are seldom used on continuous machines since there is a risk of abrasive particles collecting, or of a fraying of the blade edge occurring particularly as the result of contact with splices. Such fraying will allow streaks of liquid to remain on the squeegeed surface.

2. Wringer rollers of rubber or other resilient material are often used between processing stages on continuous machines. These are effective in removing the bulk of the liquid, although a residual surface layer of liquid usually remains. Deposits of dirt particles that tend to build up on wringer rolls may damage the emulsion or support surfaces. An emulsion coating in a particularly soft condition, as for instance before reaching a hardening fixing bath, is likely to be damaged by wringer rollers. There is also the possibility that a wringer roller may fail to rotate if sufficient pressure is used for thorough liquid removal unless the bearings are very free running, since these rollers are driven only by frictional contact with the film.

3. Compressed-air blowoffs have been commonly used on continuous machines for many years. In the past these have consisted of hollow metal castings tapered to a narrow mouth in which a longitudinal slot a little longer than the width

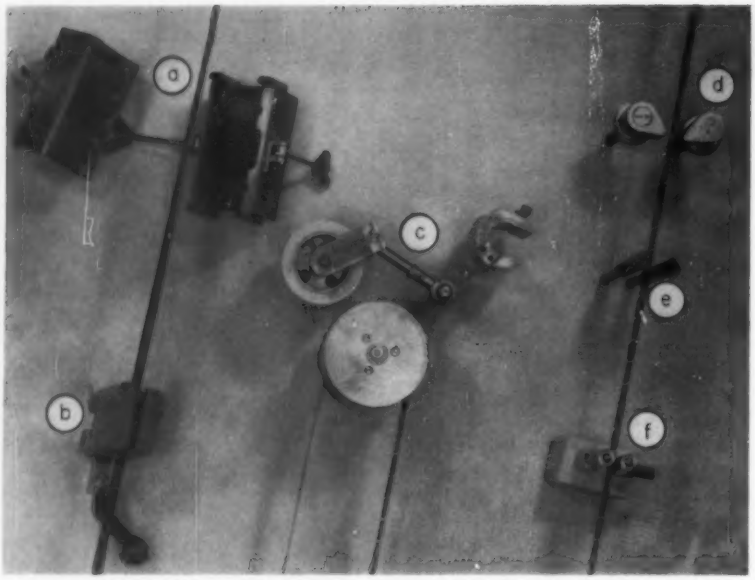

Fig. 20. Squeegees for processing motion-picture film: (a) Capstaff; (b) Ott-Lovick; (c) wringer rollers; (d) air knife—1/32-in. slit opening; (e) & (f) thin slit air knives—0.006 in. or less.

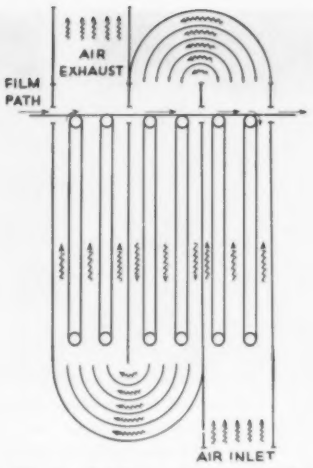

Fig. 21. Parallel-flow dryer for continuous-processing machine.

of the film is milled. Such slots have been made as wide as $\frac{1}{16}$ in. Blowoff jets are placed opposite each other on both sides of the film path, discharging from a distance of about $\frac{1}{4}$ in. from the film and at an angle of 45° against the direction of motion of the film. Sometimes several pairs of such squeegee jets are used in sequence, particularly before drying.

Blowoffs as described are expensive to operate because of the quantities of compressed air required. Those with wide slit-openings are particularly inefficient because of the large volumes of air required to obtain adequate liquid removal. Greatly improved performance is obtained by the use of much thinner slits with openings reduced to about 0.004 in. Since high velocity of air rather than a large volume of discharge is most effective in removing surface liquid, blowoffs using thin slits do a better job and greatly reduce the compressed-air requirements.

Even under these conditons, considering the energy consumption in compressed air, air blowoffs must be regarded as very inefficient for the work done. The cost of the compressed air necessary to operate the best of these blowoffs is sufficiently great that their use to prevent diluting of solution by water carry-in, or loss of solution by carry-out on the film, may not be justified by the chemical savings obtained.

4. An improved type of pneumatic squeegee was developed by John G. Capstaff about twenty years ago. This consists essentially of a hollow box with entrance and exit slots for the film. Pairs of small rollers at the entrance and exit slots are pressed lightly by spring tension against the emulsion and support surfaces and have a very narrow running clearance against the ends of the box to prevent any wasteful escape of air. Air pressure applied inside the box lifts the rollers away from actual physical contact with the film just enough to allow a thin layer of high-velocity air to pass outward from the box on both sides of the film in both directions. The air that passes over the film leaving the exit slot has some drying effect on the film. It is extremely important, however, that the surface liquid be very completely removed by the air that passes out the entrance slot over the entering film. If surface liquid remains on the film as it enters the exit slot, droplets may be scattered on the partially dry film. Such droplets are a serious problem in any squeegeeing operation in which practically all of the surface moisture is being removed. When such droplets are left on the film, defects may be produced that are far more serious than would be produced by leaving a uniform thin layer on the surface. "Hammer marks" encountered in impingement drying are an example of the type of defect resulting from surface droplets.

5. The "Venturi" squeegee was developed by Ott and Lovick[17] to overcome difficulties encountered in the treatment of soundtrack areas of Eastman Color Print Film by surface-application techniques. This type of squeegee is more effective and efficient than previous types of pneumatic squeegees.

The application of processing solution for the selective treatment of soundtrack during processing requires that any droplets or threadlets of residual liquid be removed from the emulsion surface to prevent bleeding of the applied processing solution into the picture area. The "Venturi" squeegee was intended primarily for this purpose, but squeegees of this type have since found wide use for completely removing surface liquid from film that is to be dried by impingement.

Venturi squeegees consist of two hollow members that together form a passage flared out at both ends to a cross section similar to that of a Venturi tube. At the constricted throat a narrow gap allows passage on both surfaces of the film of a stream of high-velocity air only a few thousandths of an inch thick. Air is discharged through a thin slit on each side of the throat at flat angle to the film and against the direction of motion of the film. The streams of air discharged at a pressure of about 8 to 15 lb/sq in. prevent the film from making any physical contact with the Venturi passage.

These squeegees must be accurately made and correctly adjusted to obtain complete liquid removal and to avoid producing a loud, high-pitched whistle.

6. Vacuum squeegees are used to a limited extent for the processing of motion-picture film. At one laboratory for instance, such squeegees have been used for black-and-white film processing at speeds up to 300 ft/min. These units consist of small vacuum chambers placed against the emulsion and support surfaces of the film. The only mechanical contact with the film is through soft rubber lips designed to remove liquid without physical damage to the film. A partial vacuum is applied to each chamber sufficient to strip off the surface liquid. Such squeegees operate at a very much lower rate of power consumption than the compressed-air types. Vacuum squee-

gees must be very carefully designed and maintained. Many laboratories prefer the compressed-air types because of the apparent lesser hazard of damage to the film.

Of the various squeegees described, the pneumatic types are most generally satisfactory in performance. However, even the best of these are quite inefficient considering the horsepower required to accomplish such a small amount of physical work.

F. Drying

The drying of photographic materials following wet processing is accomplished by several methods, which may be used separately or in combination.

1. Parallel-Flow Air: Drying by parallel-flow air has been used on continuous film processing machines as a general practice. Drying cabinets connected in series by reverse-bend ducts as shown schematically in Fig. 21 have been a standard design for motion-picture machines.

A common deficiency of many of the earlier parallel-flow dryers was insufficient velocity of the drying air. The passing of relatively hot, low-humidity air at low velocities over wet film results in more rapid drying at the edges than in the center. As a consequence the transition from wet gelatin to normally dry gelatin begins at the edges and progresses across the width of the film to the center. Any marked change in drying conditions for a substantial time interval during this transition leaves lines of visible surface relief corresponding to the positions of the borderlines between wet and dry gelatin at the time of the change.[18] Under particularly severe conditions a whole network of such lines is produced around the perforations and extending across the picture area.

Improvements to parallel-flow drying equipment by increasing the air velocity, reducing the drying temperature, and increasing the relative humidity, eliminate the relief image effect by causing drying to occur uniformly across the width of the film. An accepted practice for drying black-and-white motion-picture film for best physical quality has been a 20-min drying at an air velocity of about 600 ft/min and a dry bulb temperature of about 70 to 80 F at 50% relative humidity.

2. Impingement Drying: Ives and Kunz[13] and others have worked out methods of rapid drying. Of particular importance is the development of impingement drying by F. D. Miller,[19] and the specification by him of designs for such dryers. In impingement drying, shown schematically in Fig. 22, jets of air are applied at right angles to the emulsion and support surfaces at velocities in the range from 5000 to 6000 ft/min. Under these conditions very satisfactory physical quality can be obtained at drying times from 30 to 90 sec. Dry bulb temperatures of 100 to 150 F are commonly used. Full removal of surface liquid is necessary to avoid defects due to nonuniform drying. Improper conditions of velocity and temperature can result in more rapid drying at the edges as in the case of parallel-flow drying.

Because of the high static pressure required to obtain the high air velocities required, the horsepower requirements may be nearly as great for impingement drying as those for conventional dryers. The savings in space, processing time, and reduced thread-up in the machine are of course considerable.

Impingement drying is likely to produce a higher gloss on the emulsion surface than conventional parallel-flow drying. For negative films or for intermediates to be contact printed, high gloss can be undesirable. When good contact is secured in printing, Newton's rings may be apparent in the resulting print.

A few types of film become excessively brittle when dried rapidly by impingement, or by other methods employing increased drying temperatures. This brittleness is not the result of overdrying but is related to wet and dry bulb drying temperatures. The brittleness remains as a permanent final characteristic of the film. In such cases parallel-flow drying at a moderate rate is the preferred practice.

3. Drum (Conducted Heat): Drum-drying has been and continues to be the standard method for drying paper print materials on continuous paper-processing machines, and for drying individual paper prints, which are held in contact with the drum by a cloth belt. Drum-drying is more satisfactory than unsupported drying because of the much better print flatness obtained. Drum-drying is generally not suitable for film.

4. Radiant heat dryers have received only limited use. Quite satisfactory drying results have been obtained with radiant-heat dryers under some conditions, particularly as boosters in conjunction with drum- or cabinet-drying. The recent availability of improved radiant-heat panels offers the possibility of some simplification in radiant-heat dryers. Many radiant-heat dryers have subjected the photographic material to very severe treatment because no provision was made for carrying away the evaporated moisture. In such instances the emulsion coating is overheated in a blanket of warm, humid air. Even a moderate air flow is very beneficial in reducing the severity of the treatment.

IV. RECENT DEPARTURES FROM CONVENTIONAL METHODS

Conventional photographic processing methods have evolved as described above and have resulted in the present technical excellence of professional motion pictures. At the same time there have been very striking advances in radically different chemical processing techniques and in other methods of pictorial reproduction.

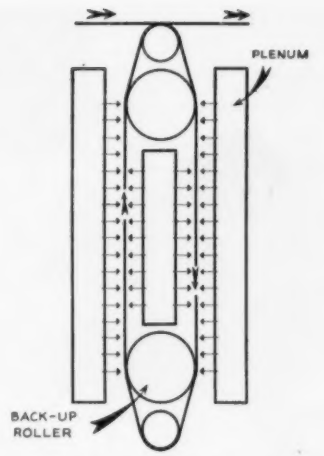

Fig. 22. Impingement dryer for continuous-processing machine.

One of the earliest examples of the departure from conventional methods was the rapid processing technique applied to race-track photographs twenty years ago. For this and similar uses a quickly available image was essential but high photographic quality was not required. Photo-recorded radar information is another example for which rapid-processing techniques give the information desired with a minimum of delay. In one such case photographic images are now obtained in as short a time as a fraction of a second after exposure.[20]

Radically different combinations have resulted in the Polaroid process, which gives the amateur photographer a finished print in a minute's time directly from the camera, and in the Verifax process, which provides office photocopy quickly and conveniently. Thus it has been shown that under some conditions chemical photographic treatment can be quick and simple.

Meanwhile, marked improvements in methods of magnetic tape recording and in xerography have presented alternative systems that have gained some preference over chemical photography for the reproduction of pictorial images for some purposes. These improvements have stemmed from intensive and highly competent research and development effort specifically directed to these ends. While it is to be expected that the unique characteristics of these systems will be fundamentally advantageous for many purposes, it is equally true that chemical photography offers very broad possibilities for an improved competitive position. Despite the attractive aspects

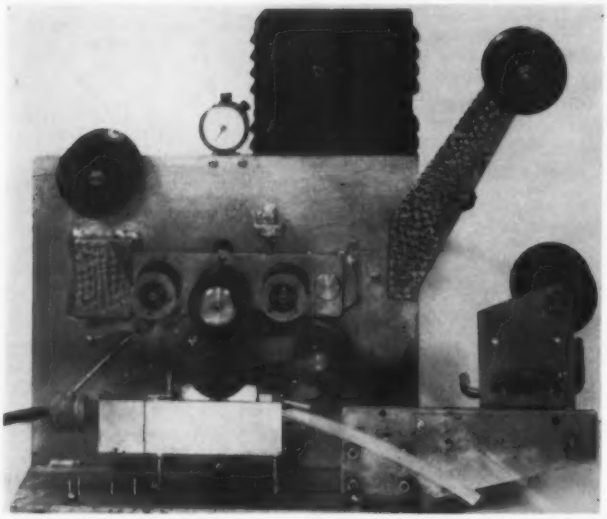

Fig. 23. Soundtrack applicator for color motion-picture film (Ott & Lovick).

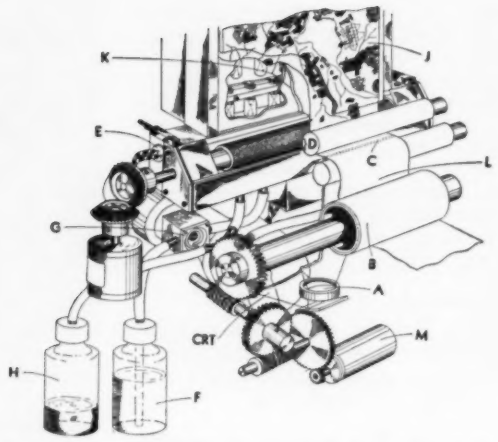

Fig. 24. Machine employing monobath treatment for processing radar film.[21] A, lens; B, rubber-covered drive roll; C, exposure station; D, processing station; E, thermostat; F, monobath solution container; J, viewing station; K, yellow glass filters; L, unprocessed film; M, servo drive motor; N, stainless-steel tube; P, dacron felt washers; Q, collar; R, nylon bearings; S, metal block.

of electronic methods, chemical treatment can in most cases be achieved with simpler and less expensive equipment.

The competitive position of such systems as video tape and xerography has been considerably enhanced by the failure to apply more advanced methods such as "hot" spray-processing in the competing photographic systems. It remains to be seen what the eventual relative position will be as more advanced and simplified processing methods are evolved and applied.

In this perspective some of the methods and equipment designs which have been described here seem unduly complex and inefficient for the work that they accomplish. If this is in fact an accurate appraisal, some justification is readily found. It has been essential that systems be standardized to serve major needs. These systems may well be unsuitable for new and specialized requirements. Certainly, for some purposes, the classical methods have of necessity been displaced. It will be of considerable interest and importance to see the extent to which the newer methods affect photographic processing technology and commercial practice.

V. FUTURE IMPROVEMENT IN PHOTOGRAPHIC PROCESSING

It seems clearly indicated that one of the main directions in which improvement will occur in photography in the future will be toward simpler and more rapid processing. Such improvements will more nearly satisfy the needs for a high-quality result in a short time at low cost.

Relatively little change in the processing of motion-picture films for theater presentation may be expected, since present facilities appear to be capable of meeting essential needs. A more general adoption of warm spray-processing for black-and-white films does appear likely, judging by recent trends.

Where photographic images are required immediately without the necessity of elaborate facilities, some newer processing techniques offer considerable promise. One is the use of an applied viscous layer of processing solution, as for instance in the redevelopment of the soundtrack on Eastman Color Print Film, Type 5382; in this case the solution is applied by a "roller bead" applicator[17] (Fig. 23). A second is the application of a viscous layer of combined solutions, such as the monobath treatment used for radar films[21] as shown in Fig. 24. A third is "flash"[22] processing in which a layer of combined solution is applied and dried down as the processing reaction progresses; this method is in commercial use for photographic paper records of oscillograph traces. These examples are cited to typify the kinds of processing treatments that seem likely to receive increasing use in the future.

Processes involving the application of heat alone, or of a chemical vapor as in the case of diazo processes, or merely the moistening of the emulsion surface, have received some limited use. However, the ultimate value and the total extent of future commercial use of such methods are difficult to appraise at present.

Looking through the patent literature over the past half century, one is impressed with the really tremendous number of inventions that have been made in photography, in photographic processing, and in photographic processing equipment. Yet, judging by the continued important advances in recent years, this must still be considered a very active field. As increasing attention continues to be directed by many workers toward simplified processing, a transition will undoubtedly occur away from conventional methods.

CONCLUSION

In spite of the advances of competing techniques, the volume and the variety of the uses of photography continue to increase. This growth may be attributed in part to the improved properties of photographic materials in speed, sharpness, and color reproduction; but also of major importance are the expanding use of audio-visual techniques in business and in education, and the increased needs for the recording of technical information in the fields of science and engineering.

Against these advances in the uses of photography lie the drawbacks of the present methods of photographic processing. These drawbacks are becoming more generally recognized as a serious detriment to photography. This is evidenced by the increasing attention and effort being devoted to improved methods of processing.

In considering the directions in which photographic processing will probably progress, two distinct situations seem clearly defined. In fields that demand the utmost in quality, such as motion pictures for theater presentation and professional pictorial work, the excellence of the results is a predominant requirement; for these, further progress along

conventional lines may be sufficient. In other fields in which speed, cost and convenience are dominant considerations, it is essential that simplified, rapid and efficient processing methods and equipment replace the present cumbersome traditional practices.

Much of the information in this paper, apart from the stated references, has come from discussions with people in the processing industry over a period of many years. Processing machines, to those who know this equipment through sometimes bitter experience, can be an absorbing subject for conversation. Along with the many well-designed and functionally suitable processing machines in the industry, one can also find a variety of equipment quite different in principle and construction from the more accepted designs. Even these unusual types seem to fulfill useful purposes. People of considerable experience have widely differing opinions on some essential aspects such as: Which are better, sprocket machines or friction-drive machines? Some machines that may appear in theory to be unworkable have been turning out satisfactory products for years. Others of seemingly excellent design are at times subject to obscure malfunctions, which can cause irretrievable loss of precious negative. Thus, there has been much to discuss.

It would be desirable to list the names of all of the people who have participated in these discussions from time to time, but the list would be much too long to print here. At least the author can express his thanks for the information passed along, and for the pleasure of these associations.

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Discussion

John A. Maurer: (*JM Developments, Inc.*): An apparent omission, it seems, is a discussion of methods of solution filtration, water filtration and air filtration, to get rid of dirt that adheres to the film during processing.

Mr. Turner: This is really a little beyond the intended scope of this paper. I feel that there are some problems of filtration here that have yet to be solved satisfactorily.

Mr. Maurer: I should like to make the comment that on soundtracks as commonly processed in the industry, the noise level is 10 to 15 db higher than it would be if dirt were rigorously eliminated in all steps.

George Lewin (*Army Pictorial Center*): Would you give briefly any information you have on methods of accurately measuring the actual development time.

Mr. Turner: Our practice for continuous machines is to attach a telltale to the film and to measure the time from entry into the developer to the time it reaches the next stage. Measurements of motor speed or shaft speed can be misleading.

Emulsion Sensitivity for the Photography of Cathode-Ray Tubes

By R. W. TYLER
and F. C. EISEN

The factors which are significant in the photography of cathode-ray oscilloscope traces were studied with a photometer built especially for this purpose and by means of photographic tests. The photometric tests made with the special photometer showed that the initial decay of the P-11 phosphor is a logarithmic function of time and that recurrent traces on the same area of the screen do not all produce the same intensity of phosphorescence. For such multiple tracing, the intensity of phosphorescence was found to increase progressively for the first several traces; and, in some cases, the intensity of phosphorescence was found to decrease after the initial increase. Photographic tests made on four films with an oscilloscope camera, used in conjunction with the oscilloscope photometer, and with two sensitometers showed that the relative sensitivities of the films for oscilloscope photography can be evaluated fairly reliably by a sensitometric test when the sensitometer light source is filtered to produce a spectral energy distribution equal to the spectral energy distribution of the phosphorescent screen and if the exposure time is 250 μsec or less.

WHEN PHOTOGRAPHING a cathode-ray oscilloscope trace, the density of the trace image on the developed film is dependent upon the exposure (irradiance × time) given the film, just as density is dependent upon exposure in any kind of photography. In many applications of photography, the proper exposure can be predicted with an exposure meter so that the camera settings and the film sensitivities necessary for a properly exposed record can be calculated. A system of photometry that could be used to calculate the exposure for photographic recording of high-speed oscilloscope traces would be very useful. However, there are many factors that have to be considered in the photometry and photography of cathode-ray oscilloscope traces, such as the intensity and duration of the phosphorescence, the spectral quality of the cathode-ray screen emittance, the sensitivity of the film, and the reciprocity-failure characteristics of the film. These factors were studied in the Kodak Research Laboratories, using a P-11 phosphor, which is commonly used for photography, and, in some cases, a P-2 phosphor.

The irradiance falling on the film when photographing an oscilloscope trace is dependent upon the radiance of each point of the trace on the screen. This radiance is, in turn, dependent upon the beam current, the accelerating potential, the spot focus and the type of phosphor. The beam current and the focus can usually be adjusted on an oscilloscope. The accelerating potential usually is not adjustable, but does vary over a wide range between oscilloscope models.

The exposure time that is effective in cathode-ray oscilloscope-trace photography is determined predominantly by the persistence time of the phosphorescence for very high spot-velocities, while at very low spot-velocities the time for the spot to travel across a given point on the screen determines the exposure time. These studies were confined to high-velocity traces.

Oscilloscope Photometer-Camera

In order to study and evaluate the time and intensity characteristics of cathode-ray phosphorescence for different excitation conditions, an oscilloscope photometer was built. This photometer consisted of an $f/2.8$ photographic objective, a slit, a field lens, a 5819 multiplier phototube with an S-11 photosensitive surface and a second oscilloscope with a preamplifier. The manufacturer's spectral sensitivity curve for the S-11 photosensitive surface shows that it has adequate range for measuring radiation from a P-11 phosphor. The slit was used to mask the face of the cathode-ray tube and thereby to minimize the effect of the background radiation. The photometer system is shown schematically in Fig. 1.

To use the photometer, a horizontal linear trace displayed on a test oscilloscope is imaged by the lens at unit magnification in the plane of the slit. The flux from the length of the trace image framed by the slit falls on the phototube directly behind the slit. The resulting photocurrents are observed on the second oscilloscope. The rise-time of the second oscilloscope was 0.03 μsec, which is not rapid enough to follow the rise of the photopulse in all cases. However, for this study, it is not necessary that the photometer follow the rise of the photopulse. It is only necessary that it follow the slower decay of phosphorescence.

The phototube and slit assembly was mounted on ways so that it could be moved out of position and a filmholder moved into position for photography of the test oscilloscope traces, using the same lens and magnification as were used for the photometry.

Photometry Tests

The method used to obtain decay of phosphorescence data with this oscilloscope photometer was as follows: The test oscilloscope was adjusted to give a horizontal sweep velocity of 1 cm per 0.1 μsec at intervals of 0.01 sec. These traces were imaged in the plane of the slit, which was 0.4 cm wide for this test. The 0.4-cm length of the trace image falling on the phototube produced a photocurrent which was displayed on the second oscilloscope. Since the transit time across a 0.4-cm length at this velocity is 0.04 μsec, the photometer system will not measure the increase in intensity correctly as the spot traverses the 0.4-cm length, because of the 0.03-μsec rise-time of the photometer oscilloscope. However, with such a short transit time, the decay at all exposed

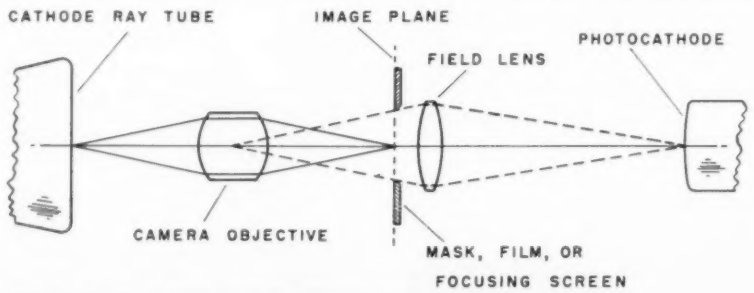

Fig. 1. Schematic drawing of oscilloscope camera and photometer.

Communication No. 2006 from the Kodak Research Laboratories, presented on October 23, 1958, at the Society's Convention in Detroit, by R. W. Tyler (who read the paper) and F. C. Eisen, Kodak Research Laboratories, Eastman Kodak Co., Rochester 4, N. Y.
(This paper was received on February 19, 1959.)

points will start at approximately the same time and the observed decay curve would not be significantly different in shape from the curve that would be obtained from the phosphorescence of a single point. The decay curves determined by plotting photocurrent against time on a logarithmic scale are shown in Fig. 2 for a P-11 phosphor and a P-2 phosphor, as seen by an S-11 photosurface. A Tektronix Type 517A Oscilloscope was used to obtain the P-11 data and a Tektronix Type 535 Oscilloscope was used to obtain the P-2 data. It is evident in Fig. 2 that the initial decay of the P-11 phosphor is a logarithmic function of time.

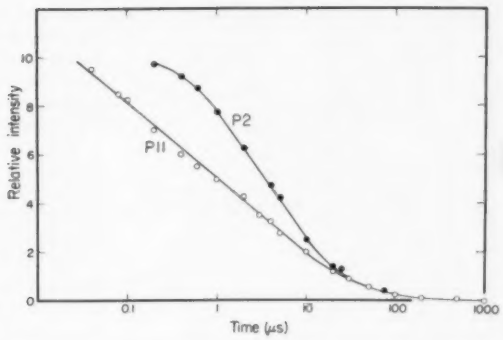

Fig. 2. Decay of phosphorescence.

The photometer was also used to obtain data on the relationship between the intensity of phosphorescence and the time interval between recurrent traces. In the photography of repeated traces, the question arises as to whether the intensity is the same for all traces. In these tests, traces at a reciprocal sweep velocity of 5 μsec/cm were triggered with an external triggering signal to produce recurrent traces over the same area of the oscilloscope screen. The triggering signal was gated to obtain a repeating pattern with suitable rest intervals. If the traces are repeated at the rate of 100/sec, with the gate open for 0.09 sec and closed for 0.11 sec, the lower graph of Fig. 3 is obtained. If the triggering is set to produce traces at the rate of 10,000/sec, with the gate open for 0.009 sec and closed for 0.011 sec, the upper graph of Fig. 3 is obtained. Both graphs show that, when the spot retraces a path after a period of rest, the intensity of the phosphorescence increases for the first several traces. The lower graph in Fig. 3 shows that the photometer current goes to zero between traces recurring at 0.01-sec intervals, while in the upper graph, the photocurrent does not have time to go to zero between the traces recurring at 0.0001-sec intervals. The minimum values of photocurrent determine a lower envelope which is a straight line (upper graph of Fig. 3). Both graphs have an envelope of peak photocurrent values which rises for the first several traces. The upper graph obtained with the 10,000/sec rate has an envelope of peak photocurrent which decreases after the initial rise until an equilibrium is reached in about 0.005 sec. This decrease is probably associated with fatigue of the phosphors in the screen. The recurrent trace tests were made with the Tektronix Type 517A Oscilloscope with a P-11 phosphor screen and a Type 535 Oscilloscope with a P-2 phosphor screen. The same results were obtained with both kinds of phosphor.

Further tests made with the oscilloscope photometer, using procedures similar to those previously described, showed that the peak intensity of phosphorescence is approximately inversely proportional to the spot velocity over a range of reciprocal velocities of 1 to 0.01 μsec/cm.

Photographic Tests

The data obtained with the oscilloscope photometer revealed some of the factors that would have to be considered if such a device were to be used as an exposure meter. There are also other problems which would have to be considered before the photometer could be introduced as a practical exposure meter for general use in oscillography. A photometer calibration based on some absolute standard would be desirable and a system of numbers relating the photometer indications to an appropriate film-sensitivity value would be necessary. An absolute calibration of the photometer would require a standard source of intermittent flashes whose period approximates the decay time of the phosphorescence. Such a standard, high-frequency source was not available for these tests. To obtain useful data about the performance of films for oscilloscope photography, practical photographic tests were made, the oscilloscope photometer being used only as a control photometer and not for obtaining an absolute calibration. The photographic tests were made with a Type 535 Tektronix Oscilloscope having a P-11 phosphor screen. The intensity setting was just under that which would give the highest radiant emittance for a horizontal trace and still permit a sharp focus. The exact intensity could always be re-established by the use of the photometer. Photographs of single-sweep linear traces were made at a number of velocities which were obtained by displaying on the oscilloscope its own sawtooth sweep potential. Such a trace makes an angle with the horizontal which depends upon the gain setting on the vertical amplifier, as indicated in Fig. 4. The velocity, u, was calculated from its x and y components, as shown. This pattern was

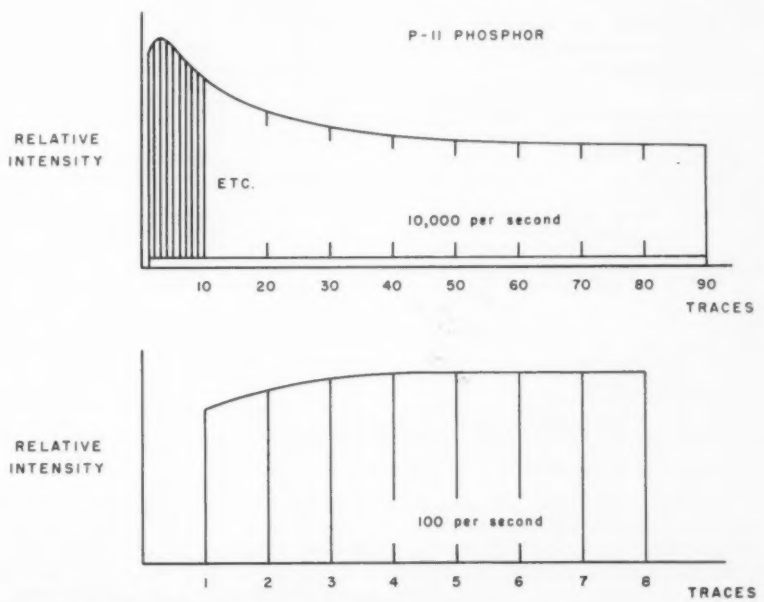

Fig. 3. Enhancement and fatigue of phosphorescence in repeated traces.

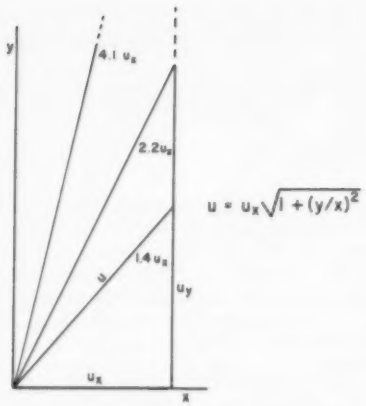

Fig. 4. Diagram showing different velocities of traces obtained by displaying a single sawtooth transient with different vertical gains.

photographed at unit magnification on Kodak Royal-X Pan Film (Rolls), Kodak Tri-X Film (135), Kodak Spectroscopic Film, Type I-D(2), and Kodak Photoflure Film, Blue Sensitive. Each film was exposed to a series of spot velocities obtained by changing the vertical gain settings.

Since forced development is customarily used for high-velocity oscilloscope-trace photography, these films were given the maximum development which was considered practical. Royal-X Pan Film was developed 25 min in Kodak Developer DK-50 at 68 F (20 C) and the other films were developed 25 min in Kodak Rapid X-ray Developer at 68 F (20 C). A sensitometric processing machine which provides continuous agitation of the developer was used. Actually, as will be shown later, no gain in effective film speed for trace recording is obtained after about 10 minutes' development.

The straight-line traces on the developed films were scanned with a microdensitometer. The maximum densities above fog of the traces were plotted against spot velocities for each film. The resulting curves are shown in Fig. 5. Royal-X Pan Film obviously records the highest velocity sweep, and Spectroscopic Film, Type I-D(2), Tri-X (135), and Photoflure, Blue Sensitive record progressively lower velocities.

Testing films by photographing calibrated oscilloscope traces which have to be evaluated by microdensitometry is a time-consuming procedure requiring careful calibration and control of the oscilloscope and oscilloscope photometer. A simpler sensitometric procedure for evaluating films for this purpose would be preferable. Therefore, sensitometric data for comparison with the oscilloscope-photography results were obtained by exposing the same films on two sensitometers. One employed a 900-w tungsten lamp operating at 3000 K and a mechanical shutter to give a 250-μsec exposure. The other used a xenon flashlamp (G.E. F.T. 214) discharging a 2-μf capacitor at 2000 v to produce a flash with an effective exposure time of approximately 35 μsec. The effective time for the oscilloscope exposure is about 10 μsec. Each sensitometer was used with a neutral step tablet and an appropriate filter to convert the illuminant to a close approximation of the energy distribution of the P-11 phosphor. The filter used with the tungsten source was a 4.90-mm-thick Corning 5030 glass plus a Kodak Wratten Filter No. 2C. With the xenon-flash source, a filter pack consisting of two layers of Kodak Wratten Filter No. 38A and one layer of Kodak Wratten Filter No. 2C was used.

Figure 6 shows the density-log exposure curves of the four films obtained with the 250-μsec exposures, and Fig. 7 shows the curves obtained with the xenon-flash exposures. These curves show that, for low densities, the Royal-X Pan Film is the most sensitive, while with a high density criterion, Photoflure Film is most sensitive. The performance of the four films for a density of 0.1 above fog, as determined by the oscilloscope test and the sensitometric tests, is summarized in Table I. These data

Table I. Summary of Film Performance at Density = 0.10 Above Fog.

Kodak Films	Oscilloscope Rel. Velocity	Sensitometric Tests Xenon Flash Rel. Speed	Sensitometric Tests 250 μsec Rel. Speed
Royal-X Pan . .	100	100	100
Spectroscopic, Type I-D (2) .	55	70	50
Tri-X (135) . . .	45	55	35
Photoflure, Blue Sensitive . . .	35	45	30

show that the sensitometric tests rank the films for threshold speed in the same order as they were ranked by the single-sweep oscilloscope recording test, although the magnitude of the differences is somewhat different. Approximate equivalence of these three tests is to be expected, despite the 20-to-1 range in exposure time because short-exposure-time, reciprocity failure is minimized with forced development of fast emulsions.*

Figure 8 shows a time-of-development series for xenon-flash exposures to demonstrate the effect of forced develop-

* J. Castle, W. A. Shelton, and W. Woodbury, "Reciprocity-law failure at very short exposure times," Proceedings of the Third International Congress held under the auspices of the Department of Scientific and Industrial Research in London on Sept. 10–15, 1956, p. 219.

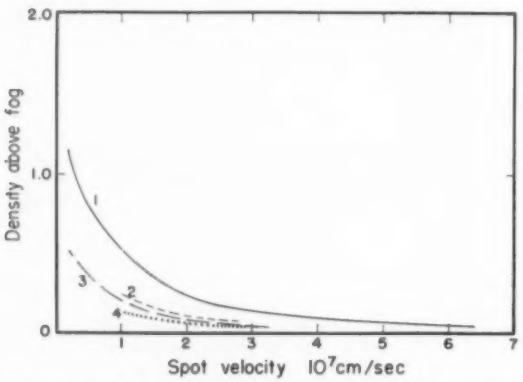

Fig. 5. Oscilloscope-trace photographs. Density vs. spot velocity: (1) Kodak Royal-X Pan Film; (2) Kodak Spectroscopic Film, Type I-D(2); (3) Kodak Tri-X Film (135); (4) Kodak Photoflure Film, Blue Sensitive.

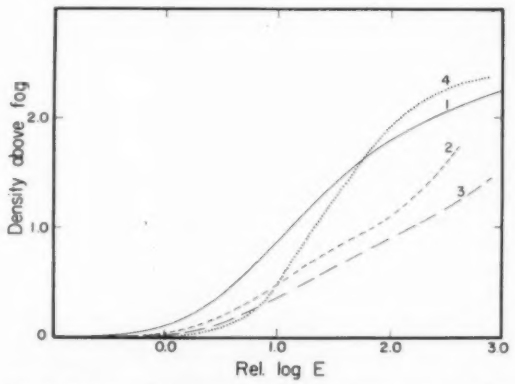

Fig. 6. Sensitometric curves. Density above fog vs. relative log exposure. Filtered tungsten illumination. Exposure time, 250 μsec: (1) Kodak Royal-X Pan Film; (2) Kodak Spectroscopic Film, Type I-D(2); (3) Kodak Tri-X Film (135); (4) Kodak Photoflure Film, Blue Sensitive.

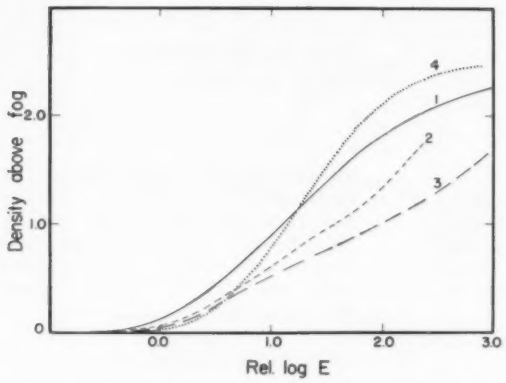

Fig. 7. Sensitometric curves. Density above fog vs. relative log exposure. Filtered xenon flash. Equivalent exposure time, 35 μsec: (1) Kodak Royal-X Pan Film; (2) Kodak Spectroscopic Film, Type I-D(2); (3) Kodak Tri-X Film (135); (4) Kodak Photoflure Film, Blue Sensitive.

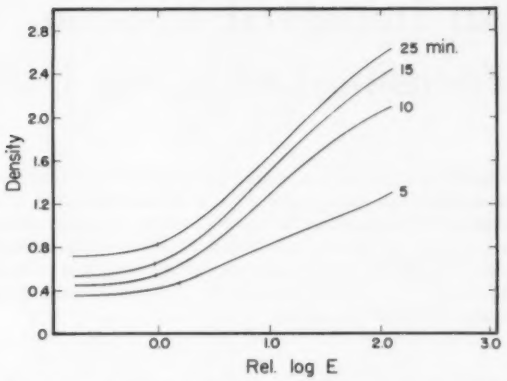

Fig. 8. Sensitometric curves for Kodak Royal-X Pan Film. Filtered xenon flash. Development times and density of 0.1 above fog points are indicated.

ment in Kodak Developer DK-50 on Royal-X Film. Speed points at densities of 0.10 above fog are marked on the curves, and it is evident that there is no significant change in film speed for development times longer than 10 min. Similar tests with Tri-X Film developed in Kodak Rapid X-ray Developer also showed that there was no significant increase in film speed for development times longer than 10 min.

Conclusions

This study has shown that the photometry and photography of high-velocity, cathode-ray oscilloscope traces is much more complex and difficult than the photometry and photography of longer-duration events. The differences between phosphors, the wide variety of circuits employed, and the variations of intensity, spot size, repetition rate, and spot velocity preclude the formulation of instructions for photography which would be generally applicable. The details of the photographic procedure for a particular application with particular equipment will have to be derived by the user by trial. This study has shown, however, that a fairly reliable indication of the relative sensitivities of films can be determined with a sensitometric test, using an illuminant which approximates the spectral quality of the phosphor and an exposure time of 250 μsec or less.

Discussion:

William L. Hughes (Iowa State College): Suppose we had two tubes, using the same beam current and accelerating voltage, but one using the P-16 phosphor and the other using the P-11 phosphor, the P-16 decaying in just a few microseconds and the P-11 decaying much more slowly. Would the reciprocity law hold? There's a little difference in spectral characteristic here, of course, and except for that difference, if one could evaluate with a spectrophotometer and make a reasonable prediction — would there be any significant difference in reciprocity characteristics here?

Mr. Tyler: No, I believe not. To answer your question in another way, one draws a reciprocity law curve over as large a region of intensity as he can, extending it to as short an exposure as is physically obtainable. You always wish you could go a little farther. The curve becomes flat before you reach the conditions of the P-11 phosphor and remains flat thereafter; that is to say, the reciprocity level appears from experiment, to hold for ever-decreasing exposure times, and this is to be expected from the theory of photographic image.

Mr. Hughes: If this is true, I have one question I would like to ask you or anyone else to comment on. If this is the case, why do we use P-11 in kinerecordings — why not use a P-16 and get rid of some of the shutter-bar problems, etc.?

Chairman: Does anyone have the answer to that question?

Charles H. Evans (Eastman Kodak Co.): I think you'll find the chief reasons are that the spectral characteristic which you mentioned is important, and that the output of energy is higher, therefore you'll get a considerably greater exposure with the P-11 than you do with P-16.

Mr. Hughes: What is the ratio of the exposures?

Mr. Evans: Well it's of the order of 10 to 1. It depends on the applications, but generally we get about ten times as much exposure with P-11 on a blue-sensitive emulsion.

Anon: What about P-24?

Mr. Evans: We are doing some work with different phosphors and have found that for blue-sensitive films the exposure obtained from P-24 is less than that from P-16 at the same beam current and voltage. For Eastman Television Recording Film, Type 5374, the ratio of exposure is about 2 to 3.

Any further comments or discussion?

Glenn E. Matthews (Eastman Kodak Co.); From the standpoint of presentation of papers at our meetings, I wanted to mention especially the nature of the slides that are used in this presentation. We are constantly striving to encourage authors to present papers with better slides and to make the very best possible use of the visual material that supplements their oral presentation. As you probably noted this week, we've run the gamut again of slides that are so small on the screen that they can't be seen except by people in the first row to slides that are so full of information that one slide could be left on throughout the whole presentation and still we wouldn't have time to study all the details. The type of slide used in this paper demonstrates size of lettering and a minimum of lettering to convey the information, but, over and above that in this instance, I might say that a lot of research has been done over the past few years at the Laboratories in Rochester on the use of color as a background for the presentation of the slide material. From our examination of a great many color combinations, this blue background as used on Mr. Tyler's slides has been generally considered from all researches to be the most pleasant for the audience. Also, having the dark ground for the light letters is considered to induce much less visual fatigue. I'd be interested to know from a show of hands how you like this type of slide as compared with the more or less characteristic slide of black letter against the large white ground. How many of you favor the use of this type of slide material?

That's obviously almost unanimous, but perhaps we should say how many didn't like this particular slide?

I guess it is unanimous then.

I would like — from an Editorial Vice-President's standpoint — to make the comment that I would urge all of you in presentation of papers at meetings to give careful consideration to a slide material as that helps very greatly to put across the information that you wish to convey.

Anon: You only asked about this one versus white with black letters. What about the black background and white letters?

Mr. Matthews: Well, we might see if we have any preference to the black background against white — are there those here who would care to express by their hands that they prefer the black background over the blue background?

I don't see any vote on that, but I just wish to say in passing that there is an American Standard on the preparation of slides and there's also information that is available from the Society office and we are very anxious to give others all the encouragement possible to make better presentations of their material.

An Improved Vidicon Focusing-Deflecting Unit

By J. CASTLEBERRY
and B. H. VINE

The effect known as beam-landing error or "porthole" in vidicon cameras is eliminated through the use of a suitable coil configuration. The axial positions of the coils are chosen so that the beam electrons approach the target with only an axial component of velocity at all times. Exceptional signal uniformity independent of signal-electrode voltage and focus field strength is then obtained with a vidicon having a uniform photoconductor. A particular coil design and the results obtained with it are discussed.

THIS PAPER is the result of efforts to obtain a vidicon system which would provide especially uniform sensitivity over the entire scanned area. In the past the most prominent source of sensitivity variation in vidicons was the nonuniform thickness of the photoconductive target layer. The recent development of vidicons having very uniform target layers has served to focus attention on a second source of nonuniformity, beam-landing error, which lies in the design of the focusing and deflecting coils rather than in the vidicon itself. This paper describes the design of a focusing-and-deflecting unit which effectively eliminates beam-landing error.

Cause of Beam-Landing Error

The diagram at the top of Fig. 1 shows how beam-landing error arises. The mesh is operated at about 300 v and the target (signal electrode) at about 30 v, both positive with respect to the cathode of the electron gun. The electron beam from the cathode passes through the mesh into the decelerating field between the mesh and the photoconductive layer and deposits electrons on the surface of this layer, thus driving the surface potential down toward cathode potential until the surface potential attains a certain limiting value, after which electrons are not deposited but are reflected back. During the short time required for the beam to pass over an element of target surface, the photoconductor may be considered an insulator.

The limiting value of surface potential is equal to cathode potential if the electron beam approaches perpendicular to the surface. With conventional vidicon focusing and deflecting coils, this condition occurs only at the tube axis, i.e., the center of the picture. When the beam is deflected during scanning, the electrons pass through the mesh at an angle, θ, to the axis, and the surface potential is driven down until the beam just grazes the surface as shown in the upper part of Fig. 1. As the electrons pass through the mesh, they have energy eV_m, where e is the electron charge and V_m the mesh potential. This energy is distributed between the lateral and axial components of the angle θ proportional to the squares of their velocities. The axial energy is $eV_m \cos^2\theta$ and the lateral energy $eV_m \sin^2\theta$. The lateral energy of the beam electrons remains constant throughout the uniform axial field region between the mesh and the photoconductor. Where the electrons just graze the photoconductor each has only lateral energy $eV_m \sin^2\theta$ and the limiting surface potential becomes $V_m \sin^2\theta$. When typical focusing and deflecting coils are employed, θ is about 0.1 radian at the corners of the picture. The final corner potential after scanning through a mesh at 300 v then is 3 v, and the potential of the scanned surface varies as shown in the lower part of Fig. 1. The beam-landing error would be 3 v.

Effect of Beam-Landing Error

The driving-potential difference used to produce photoconduction is the signal-electrode voltage minus the surface potential. For a 3-v beam-landing error, therefore, the driving potential difference varies across the scanned area as shown in the upper part of Fig. 2. Dark current and light sensitivity are both quite sensitive to driving-potential difference so that for uniform illumination a typical output current varies as shown in the lower part of Fig. 2.

At intermediate values of illumination on the tube face and the corresponding intermediate signal-electrode voltages, the decrease in sensitivity from the center to the edge of the raster is about 20%. Although this variation is not noticeable on the picture-tube display, it is noticeable on an oscilloscope display of the video signal. At the high light levels and corresponding low signal-electrode voltages used in film cameras to make lag insignificant, however, the beam-landing error is an appreciable fraction of the signal-electrode voltage and the sensitivity is significantly lower at the picture corner. At low light levels where a high signal-electrode voltage is necessary to develop reasonable signal, there is considerable dark current and, although the average value of the dark current can be readily suppressed in signal processing, the beam-landing error may produce a variation in dark current which is large relative to the signal.

Presented on October 22, 1958, at the Society's Convention in Detroit, by J. Castleberry, Industrial Electronic Products, Radio Corp. of America, Camden, N. J., and B. H. Vine (who read the paper), Electron Tube Div., Radio Corp. of America, Lancaster, Pa.
(This paper was received on October 10, 1958.)

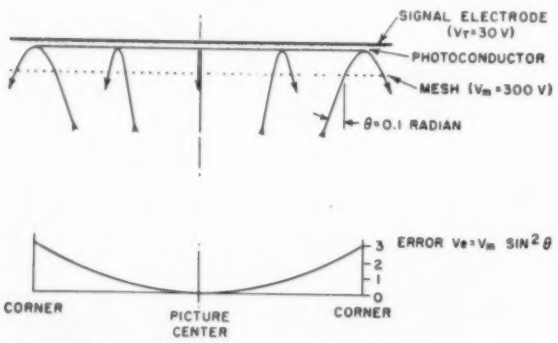

Fig. 1. Diagram illustrating cause of beam-landing error and variation across picture.

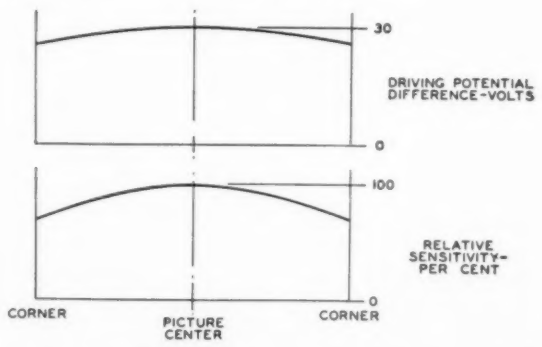

Fig. 2. Variation of driving-potential difference and of sensitivity across picture.

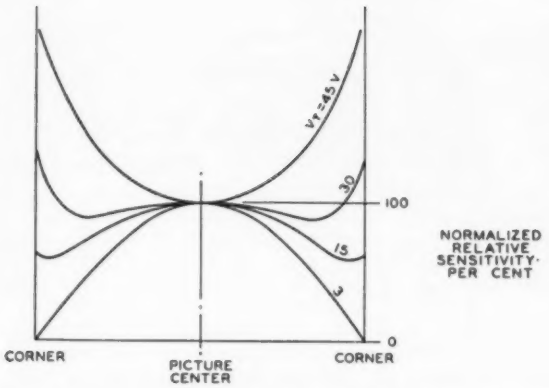

Fig. 3. Variation of sensitivity over surface of faceplate as a function of signal-electrode voltage.

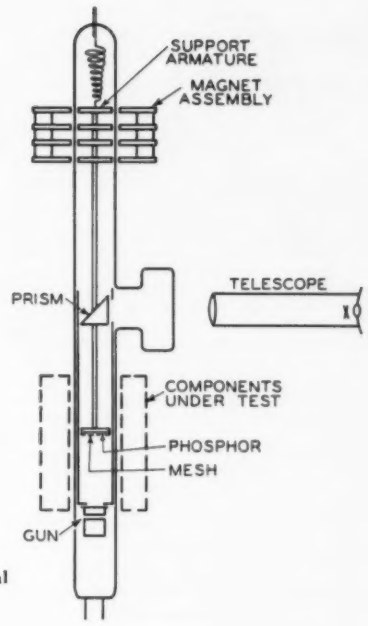

Fig. 4. Diagram of special test apparatus.

The preceding discussion has assumed that the photoconductor has a uniform thickness. Fortunately, in the early development of vidicons, the photoconductor layers were actually thinner at the edges than in the middle of the faceplate and tended, therefore, to compensate for the beam-landing error. This compensation is only approximate at best and may require a choice of signal-electrode voltage which does not allow full use of the vidicon's sensitivity. For such a photoconductive layer, the sensitivity over the surface of the faceplate varies with signal-electrode voltage as shown by the curves in Fig. 3. These curves show reasonable compensation at 30 v on the signal electrode. The large signal at the corners of the picture for high signal-electrode voltages has been called *flare*. At high signal-electrode voltages, photoconductor nonuniformity completely overrides the beam-landing error.

A method has been developed in which compensation for beam-landing error is obtained by the use of a modulating voltage of a suitable waveform supplied to the cathode. The modulating waveform contains parabolic components of both the horizontal and vertical scanning frequencies and is of such polarity that the cathode voltage is lowered as the beam approaches the edges of the scanned area. Also the horizontal component of the waveform should have greater amplitude than the vertical component. This disadvantage of cathode modulation is the extra circuit required and the necessity for adjusting the amplitudes of both components.

An ideal situation would be one in which the focusing and deflecting coils are so designed that the beam, whether deflected or not, arrives at the surface of a photoconductive layer of uniform thickness on a path perpendicular to that layer. The beam would then drive the entire scanned surface down to cathode potential and there would be no beam-landing error.

The Beam Path

Measurements of the target-cutoff-voltage difference can be made by the use of a special vidicon tube which has no photoconductive layer on the signal electrode. The target is operated near cutoff for the center of the faceplate, and the voltage increase required to make the signal at the corners of the faceplate equal this voltage is the beam-landing error.

These measurements, however, give no information as to how the coils in the deflecting and focusing unit should be modified to eliminate beam-landing error. A special tube was built which could be used with any given deflecting and focusing unit and in which the path of the beam could be simulated and determined. Figure 4 is a diagram of this apparatus.

A standard vidicon gun and a phosphor-coated plate are enclosed in a sealed-off tube. The phosphor-coated plate is supported by a long rod attached to an armature inside the tube. An external magnet is used to locate the armature. The long rod is employed so that no significant field from the support magnet will extend into the test region.

The plate can be moved to sweep out almost the whole of the space through which the beam may pass. The point in this space where the beam strikes the plate is observed by means of a short-focus telescope mounted on a three-coordinate slide. The two lateral slides have graduated drive screws which, in conjunction with cross hairs in the telescope eyepiece, allow measurement of the lateral coordinates of the beam. The beam is sufficiently narrow, even at out-of-focus points, so that it is not difficult to set the cross hairs on its center. A cable with suitable pulleys is used between the telescope axial slide and the support magnet to keep the telescope in focus on the phosphor-coated plate. Values for the beam-landing error which were calculated from the slope of the beam as determined in this apparatus agreed with values obtained with the vidicon having no photoconductive layer.

A typical beam path determined in this apparatus for conventional deflecting and focusing coils is shown in Fig. 5. In the diagram shown, the lateral scales are twice the axial scales. The signal electrode and photoconductive layer together are called the target. As can be seen, the lateral velocity of the beam, which is the error in velocity, has two independent components. It is necessary,

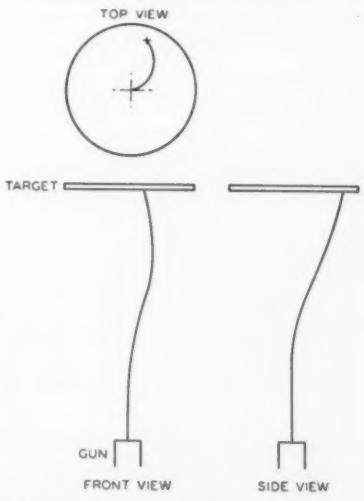

Fig. 5. Typical beam path for conventional deflecting and focusing coils.

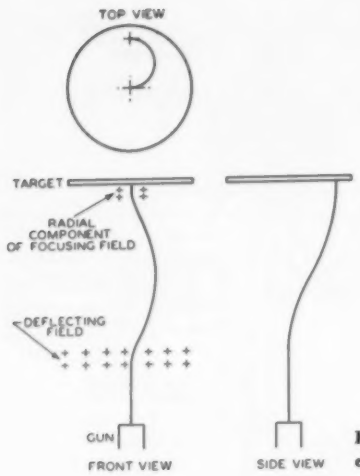

Fig. 6. Synthesized beam path which eliminates beam-landing error.

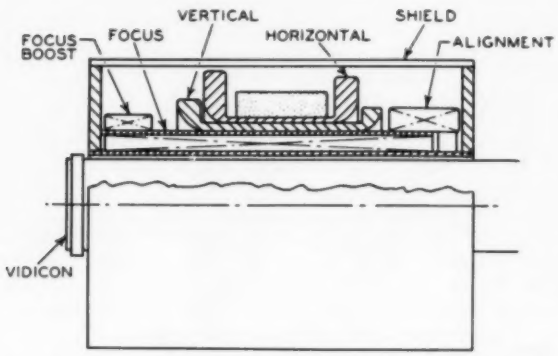

Fig. 7. Sectional view of practical deflecting-and-focusing unit.

therefore, to have at least two independent design parameters which can be adjusted to eliminate the lateral velocity of the beam. It is convenient to choose the radial and tangential components as the independent lateral components. The radial component is the direction along the radius from the tube axis to the point under discussion. The tangential component is the direction perpendicular to both the radius and the tube axis.

Synthesis of a Solution to the Problem

A design which has no beam-landing errors may be synthesized, as shown in Fig. 6. Consider a uniform axial focusing field and a deflecting field of limited axial extent. The deflecting field gives the electrons a lateral velocity and thereafter the beam path is a spiral. If the distance between the deflecting field and the target is chosen correctly, there will be just 180° of spiral, and the electrons will have some tangential component of velocity but zero radial component when they arrive at the target. Furthermore, if a suitable radial magnetic field is placed near the target, this tangential component can be reduced to zero.

The flare of the magnetic field at the end of the focusing coil has the required properties. At any point, the radial component of the magnetic field is approximately proportional to the radius, which is as it should be to cancel tangential velocities which are proportional to the deflection distance. The required two adjustable design parameters are present. The position along the axis of the tube of the effective deflection center of the deflecting coils controls the amount of spiral and hence the radial velocity of the electrons as they reach the target. Thus, by adjustment of the axial positions of the deflecting coils, the radial velocity of the beam electrons at the target can be made positive, zero, or negative. The position of the end of the focusing coil with respect to the tube target determines the amount of flare field through which the beam passes. Thus, the tangential component of electron velocity at the target can be made either direction or zero depending on the axial position of the focusing coil relative to the tube face.

In brief, with a given focusing coil and deflecting yoke, radial velocity at the target can be eliminated by suitable axial positioning of the deflection coils, and tangential velocity at the target can be eliminated by suitable axial positioning of the end of the focusing coil.

The Practical Design

On the basis of this simplified model, focusing and deflecting coils have been built and adjusted so that the beam arrives perpendicular to the target all over the scanned area. Because the deflecting and flare fields are necessarily of considerable axial extent in conventional coils, the focusing coil was placed inside the deflecting yoke in the model to produce a strong, localized flare at the end of the focusing field. Most other deflecting-and-focusing units are made with the focusing coil outside the deflection yoke. The location of the focusing coil in the new units prevents the use of vidicon tubes having a side tip-off; but, because those tubes with which the new unit can be used advantageously have no side tip-off, this condition creates no problem.

Figure 7 shows a section of a practical design of such a focusing and deflecting coil unit. The front flange of the unit carries small blocks which butt against the signal-electrode ring of the vidicon tube, thus locating the axial position of the tube and centering it in the coils. The axial position of the tube and the axial position of the deflecting yoke are fixed and have values which were chosen by trials on prototype units to give a zero beam-landing error. Small errors in the position of the deflecting coil and tube are not especially serious. Under standard operating conditions, a $1\frac{1}{16}$-in. misplacement from the optimum position causes a beam-landing error of about 0.2 v. This error is not significant when compared with the 3- to 5-v beam-landing errors which occur with conventional yokes.

This particular design has an extra section of focusing coil at the front end to shape the focusing field at this end. This extra coil section was added because the optimum position of the tube in a uniform focusing field was inconveniently close to the end of the focusing coil.

Figure 8 is a photograph of this unit with magnetic shield removed to show the coils. The tube positioning blocks were not on this prototype unit.

Performance of the Practical Unit

With this unit, the residual beam-landing error is less than 0.2 v, a significant improvement over existing units in which it is 3 to 5 v, and the total geometric distortions are within 1% on the ball-type linearity chart. The resolution, both center and corner, is as good as with the best existing units.

The deflecting power required by the new unit is nearly twice that required by other units of the 200SD series such as the 200SDU103. The impedance of the deflecting coils is the same as those of the other units of the 200SD series, but they could readily be made to suit any driving circuit. The new unit is 4 in. long, exclusive of terminals and has an outside diameter of $3\frac{1}{8}$ in.

To take advantage of the uniform land-

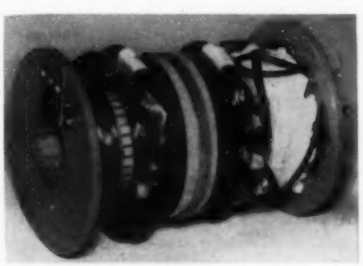

Fig. 8. Focusing and deflecting coil unit with magnetic shield removed.

ing provided by this unit, it is necessary to use a vidicon having a very uniform photoconductive layer, such as the RCA 7038 and 7262 vidicons for which it is primarily designed. With this combination of tube and unit, the uniformities of both signal current and dark current are better than can ordinarily be obtained with other tube-yoke-focus combinations even when they are carefully adjusted to balance flare against beam-landing errors. The oscilloscope display of video signals from the combination of uniform tube and uniform coils looks flat with uniform light. The scanning must be carefully adjusted for linearity to obtain this result.

A corollary advantage of the combination is that the signal-electrode voltage may be adjusted over a much wider range of values, both higher and lower than normal, without encountering difficulty with nonuniformity. Another advantage is that higher-than-normal beam-focusing voltage may be used without severe loss of signal at the corners. The advantage of higher-than-normal beam-focusing voltage is increased resolution.

This work has been done entirely around the 1-in. vidicon and single loop-of-focus operation. The design may be scaled up or down using the relative length of the beam paths to give the scaling factor, provided the new tube also is operated with a single loop of focus. It also seems reasonable that a permanent-magnet-focusing arrangement could be designed to provide the required focusing field.

Acknowledgment

The assistance of J. B. Bucher in making the many trial runs and his helpful suggestions are gratefully acknowledged. The support of R. G. Neuhauser also contributed greatly to the success of this project.

Discussion

T. Worswick (B.B.C., London): You stated that with this new coil you can put up the beam focus voltage and thereby get improved resolution. Can you give some idea of the degree of improvement? For example, with a normal vidicon such as we customarily use, the effect of aperture is quite large—the aperture loss at the edge of the band, say 500 picture points, is 10 db. What is the corresponding aperture loss that you get when this assembly is used?

Mr. Vine: By going to higher beam focus voltages and also higher focus field, you can increase the resolution in the center—something that's noticeable—I should say 25 to 30% in terms of the number of lines at a given amplitude response; i.e., 25 or 30% increase in number of picture points for a given aperture loss.

Making Black-and-White 2 by 2 Slides for Television

By RALPH J. OLIVIERI

A process for making 2 × 2-in. slides is described. This process, which employs Polaroid film, is fast and economical. Step-by-step instructions are given.

In devising a new method of making 2 × 2-in. slides, one aim was to find a process less wasteful than that of photographing on 35mm film, which requires exposure of the entire roll. After making two or three slides, the remainder of the roll must be sacrificed. This waste is costly even though a roll of 35mm film is relatively inexpensive. Among other advantages, the method described below eliminates this waste. This method does not involve the use of chemicals and does not require a darkroom. It does require time, patience and experimentation.

The following equipment is needed: (1) Polaroid Copymaker No. 208; (2) Polaroid Camera 95A ($3\frac{1}{4} \times 4\frac{1}{4}$-in.); (3) Polaroid close-up attachments; (4) Polaroid Film Type 46L; (5) one sheet of jet-black posterboard; (6) sheet of gray or white posterboard; (7) one box Lindia plastic 2 × 2 slide mounts; (8) one pair of white gloves; and (9) one pair of scissors.

Only eight $3\frac{1}{4} \times 4\frac{1}{4}$ slides can be made from each roll of Polaroid 46L film, but this method enables users to make 32 slides from each roll. Almost any type of artwork can be reproduced in the 2 × 2 size, provided the original measures 4 × 5 in. A number of TV stations use $3\frac{1}{4} \times 4\frac{1}{4}$-in. rear-screen slides. This process, using Polaroid 46L, can be adapted to make most of their 2 × 2 slides.

A contribution submitted on May 14, 1958, by Ralph J. Olivieri, Film Director, KSLA-TV, Channel 12, P.O. Box 92, Shreveport, La.

Step-by-Step Procedures

Figure 1 shows the Polaroid camera, copymaker, close-up lens and plastic ground glass. The camera is shown in proper position, lined up with the copymaker, raised to the 13-in. mark and copy lens No. 2 attached. The cross lines of the plastic ground glass must be exactly in line with the lines on the copymaker easel board. This is extremely important because all four slides must be photographed exactly even (Fig. 2).

Step 1: Rectangular lines on the easel board of the copymaker permit the placement of a photograph or artwork of any size on the correct position for photographing by indicating the correct distance between camera and artwork for making a copy of the desired size. The outside rectangle (line 8) is then measured. The measurements should be $10\frac{1}{2}$ in. wide by 14 in. long.

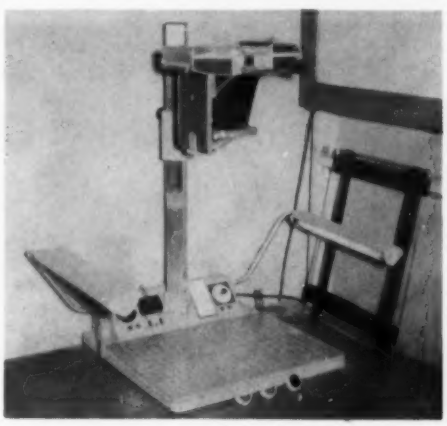

Fig. 1. Polaroid 95A camera, copymaker, close-up lens, and plastic ground glass.

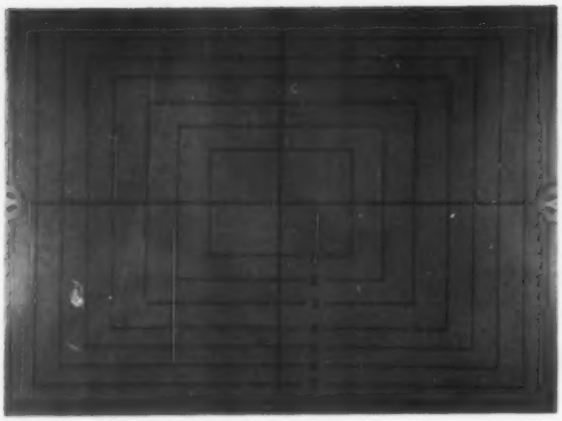

Fig. 2. The easel board face.

Fig. 3. Three-fourths (exactly) of easel board covered by black posterboard.

A piece of posterboard (dull jet-black) is cut to $10\frac{1}{2}$ in. with the cut true and all corners square. The posterboard can be about $\frac{1}{8}$ in. thick but must be black on only one side. When the board is cut it should fit exactly on the No. 8 rectangular lines. Gloves should be used in cutting this board so that fingerprints will not show.

Step 2: After the posterboard is cut, exactly one-fourth of the board ($5\frac{1}{4} \times 7$ in.) is measured with a ruler. This portion of the posterboard is then cut with a sharp razor blade or knife. The cut must be exactly square. The posterboard should then be placed on the easel with exactly one-fourth of the easel visible (Fig. 3).

The second posterboard is cut to $10\frac{1}{2} \times 14$ in. The same procedure is followed as in making the first cut except that the cut is made in the opposite corner (Fig 4). Each board will serve for making two slides in opposite corners.

Step 3: The next step is to cut a piece of white or gray posterboard exactly $5\frac{1}{4} \times 7$ in. (Fig. 5). When this board is cut, it should fit into both black posterboards and cover exactly one-fourth of the easel rectangle. A piece of 4 × 5-in. posterboard is then cut and placed in the center of the $5\frac{1}{4} \times 7$-in. posterboard. The 4 × 5 piece is for marking only. The 4 × 5 board should be outlined in ink to show where to place the 4 × 5 artwork.

Step 4: After these preliminary steps are accomplished, the next procedure is that of making the slides. One of the black posterboards should be placed exactly on the easel No. 8 line and the remaining quarter covered with a gray or white board (Fig. 6). A 4 × 5-in. photograph or artwork is placed in the 4 × 5 area previously marked. The posterboards must be exactly in the No. 8 rectangle. This is preparatory to making the first exposure for the first slide.

Step 5: Using the No. 7 exposure number for the lens opening, the operator then (1) sets the focus at infinity; (2) raises the camera to exactly the 13-in. mark; (3) attaches the close-up lens No. 2 to the camera lens; and (4) sets the time knob to "B" (bulb). A cable release should be used to make the exposure. The exposure will vary, depending on the density or lightness of the material to be photographed. On most exposures, a quick push and pull on the cable release will be sufficient (Fig. 7).

Step 6: After the first exposure is made, the black posterboard is turned to expose the opposite corner for the second exposure, following the same procedure as in Step 5. There is no danger of a double exposure of the film because the black side of the board protects the film (Fig. 8).

Step 7: After one piece of film has been exposed twice, the other black poster-

Fig. 4. Second board cut to expose opposite corner of easel board compared with Fig. 3.

Fig. 5. Proper position on easel board to place artwork.

Fig. 6. Black posterboard covering easel board except for artwork area.

Fig. 7. Artwork in 4 by 5-in. marked area.

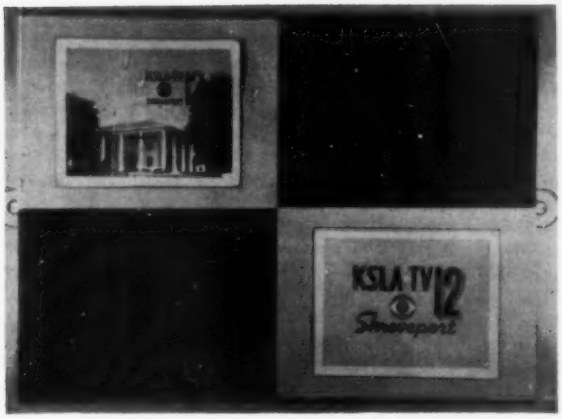

Fig. 8. Two exposures made using one black posterboard.

Fig. 9. Three exposures made on one piece of film.

board is put into use. At this step it is important to bear in mind which two sides of the film have been exposed, as the posterboard is placed on the easel for the third exposure. The procedure of Step 6 is repeated. After making the third exposure, the posterboard is turned around for the fourth and final exposure on the same piece of film (Fig. 9).

Step 8: The 46L film should be processed in the manner recommended by Polaroid Corp., allowing two minutes for developing. After development, when the film is removed from the camera back, four separate pictures will be visible. After drying, the film should be fixed with Polaroid Dippit solution and allowed to dry before mounting. The film must not be mounted while wet. After the film is processed and completely dry it is ready for cutting and mounting. A pair of white gloves should be worn while the following procedure is carried out: A 2 × 2 piece of glass is placed on the non-emulsion side of the film which is cut to glass size. The film must be centered to the glass and cut along the edges. The film is then placed between 2 × 2 pieces of glass and placed in the Lindia plastic glass mount. The same procedure followed in mounting the other three pictures then makes four 2 × 2 black-and-white slides (Fig. 10). The entire process should be completed in about five minutes.

Fig. 10. All four items on one film sheet.

This process was developed by the author at KSLA-TV, Channel 12, Shreveport, La., and has been found to be extremely useful, especially in situations where slides are needed quickly.

Language Translation by Machine

By MAX G. KOSARIN

The process of mechanical translation involves four main steps: (1) coding the source language for input data; (2) producing a word-for-word translation; (3) translation of sentences and phrases; (4) output of complete translation in target language. Machine translation is possible for foreign versions of motion pictures. Development of an automatic print reader presents a challenging problem in the field of motion-picture and television engineering.

THE DRAMATIC possibilities of machine translation seem to have led to some exaggerated ideas of what actually has been accomplished in this field. It is *not* possible (as some feature stories seem to suggest) to produce a perfect translation of a literary or scientific work by presenting the machine with a text and then pressing a button. But after fancy has been sifted from fact a sufficiently remarkable record of work-in-progress remains to justify a sober assessment of the impact machine translating may have on motion-picture and television engineering.

What, then, *is* machine translating? Basically it is the automatic translation of languages by an electronic digital computer, or a special purpose machine. Ideally, there are four elements or phases involved in the process:

1. Input of the source language, that is, the language to be translated.
2. Search of dictionary storage, to arrive at word-for-word translation.
3. Sentence-for-sentence translation through grammatical processing.
4. Output, that is, the printing out of the translation in the target language.

Groups Interested in Mechanical Translating

Complete mechanization of the process of translation is the goal of those presently engaged in the automatic translation of languages, notably in the United States, England and Russia. In the United States, research in mechanical translation was given impetus at the Massachusetts Institute of Technology about six years ago, when a group of outstanding educators in the field of languages, research scientists in the application of computers, and others in related activities, conferred and decided to investigate whether computers could be used to set up an automatic dictionary by word-for-word translation and then to proceed to sentence-for-sentence translation by the analysis of syntax. This would involve exhaustive research into the nature of language and its rules.

Subsequently, in 1954, International Business Machines Co. demonstrated the possibilities of translation with the Model 701 General Purpose Computer in a joint program with the Institute of Languages and Linguistics of Georgetown University. Meanwhile, at MIT, a journal called *MT* (mechanical translation) was launched. This publication is devoted to the reporting and evaluation of the work of research groups in the field.

Recognition of the possibilities of machine translating by the Army, Navy and Air Force represented another factor in its development. Grants of funds made possible long-range programs in the specific requirements of translating Russian scientific writings into English. Such organizations as the Rand Corp., Ramo-Wooldridge Corp. and others began research into separate elements of the process. Rand, for example, undertook the development of texts and glossaries in the Russian language for utilization in computers.

Ramo-Wooldridge, under contract to the Rome Air Development Center (RADC), has been studying the problems of translation from Russian to English. Research of other groups has been evaluated and recommendations made for continued experiments in particular aspects of machine translation. One result of this research is the recently developed Photoscopic Memory Device, now in test operation at RADC.

Financial support and direction of effort in this field have been undertaken by the National Science Foundation, which has become the clearing house for groups engaged in research in mechanical translation. It has become apparent that it is most urgent to have increased communication among these groups in order to make known, one to the other, progress being achieved in separate projects. This should serve to eliminate unnecessary duplication of effort and fruitless areas of research while facilitating cooperation programs showing promise.

Lines of Research

At Berbeck College in London, England, a group has been working on machine programs for translating. In the engineering development, the emphasis has been on extending the storage capacity of the computer in an attempt to solve linguistically the problem of multiple meanings and ambiguity.

In Russia, experiments in the use of computers for automatic translation have been in progress since 1955. A delegation of American Scientists visiting Moscow in 1956 were invited to a demonstration of a Soviet machine in which a dictionary of about 1000 words actually composed phrases. It is reported that interchange of experimental experience between American and Russian researchers in this field is increasing.

Word-for-Word Translation

Referring to the second element or step in mechanical translation — search of dictionary storage to arrive at a word-for-word translation — an investigation of the experiments and research of the leading groups in mechanical translation work indicates that such a translation is feasible at the present time, although it might be a rough, imperfect transference from one language to another.

The Ramo-Wooldridge group reports that "The mechanization of dictionary or glossary look-up and subsequent word-for-word substitution of target language for source language is elementary and immediately achievable.... Refining word-for-word translation is about all that *can* be done within the present state of the art."

The Computation Laboratory at Harvard University has been working with word-for-word translation to organize a Russian-English dictionary, using a Univac Computer.

Sentence-for-Sentence Translation

To accomplish sentence-for-sentence translation is a tremendous step beset by numerous problems of multiple meaning, semantic ambiguity and the problems of syntax. With regard to "meaning" it is obvious that the manipulation of idioms presents great difficulty. This entails, among other things, the building up of glossaries in the storage mechanism. Research in this problem of multiple meanings has been proceeding at the Rand Corp.

Research at the University of Washington is directed toward logical grammatical processing of word-for-word translation to improve the quality of the final result. This team of researchers is proceeding on the premise that a skilled human translator does his work by a translation or transference of *thoughts*, while an unskilled translator translates first on a word-for-word basis and then

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improves his work by adjusting the context of the individual words. The machine translation program is based on similar steps; first, an automatic dictionary operation followed by a processing, grammatically, of the word-for-word transference. The problem involved in the latter step might be called "mechanization of the unskilled translator."

In the author's opinion it is unwise to assume that the difference between skilled and unskilled translators is that the latter translates on a preliminary word-for-word basis. The difference between a skilled and an unskilled translator may rather be simply a matter of greater or lesser facility and fluency in the source and target languages.

Print Reader

The potentialities of the Automatic Print Reader cannot be underestimated. As noted above, the first phase or element in mechanical translation is input operation, which involves the transformation of the printed or written text of the source language into machine forms or symbols. At the present time, punched cards or tapes are used in this operation. A human operator must prepare the material going into the translation apparatus. The print reader would take in a page of text at a "glance" and instantaneously "sense" the entire page. A survey on this subject will be issued by the Rand Corp. in the near future.

The British Government Information Service, in a report on work on a new piece of equipment, published in *Electronics in England* said, "It is an electronic eye which has been *taught* to read from ordinary type. Instead of training to feed an electronic brain with mathematical formulae, it will be possible to give it a sheet of typewritten figures, which it can read and assimilate, turning the type that it sees into chains of impulses to be passed instantaneously to the computer. The *electronic reader* has dramatic possibilities because there is no doubt that now it has *learned* to read figures, it will eventually be able to *read* letters and appreciate words." The implications of a machine that can be *taught*, that *learns* to read, and that reads and *appreciates* words is something to ponder.

Leaving aside the startling implications and probable future developments and applications, what, exactly, is the present status of mechanical translation? Researchers in the twin fields of computer and language translation have no illusions about the complexity of their tasks and the progress they have made. An evaluation of statements by scientists working in these fields indicates that a sentence-for-sentence, or phrase-for-phrase translation, syntactically and semantically correct, must await the outcome of research into the many linguistic problems of grammar, multiple meanings, and other nuances of language. Conservative estimates are that these things are at least five years away.

At the Harvard Computation Laboratory, Dr. Anthony Oettinger has been compiling a Russian-English mechanized dictionary with thousands of individual entries recorded on magnetic tape, each word serialized. He has proceeded on the premise that, for the ultimate goal of complete, grammatically correct translations to be achieved, an instantaneous dictionary is a prerequisite. A word-for-word translation is achievable now which can be edited into an elegant, correct translation in the hands of a technical expert in the target language. In other words, it is Dr. Oettinger's premise that it is preferable to obtain a technically correct word-for-word translation, which can be post edited, instead of a sophisticated translation which may be inaccurate or inadequate from the viewpoint of technical translation.

In the author's opinion, an automatic or mechanized dictionary and glossary would be an extremely useful tool in the hands of a human translator. To have immediately available a choice of appropriate terms, phrases or other lexical data, which otherwise would entail exhaustive research, would permit the translator to concentrate time and effect on the transference of thoughts from one language to another.

Discussion

Barton Kreuzer (RCA): Why not a document transcriber or reader instead of piping this in manually? Even if we missed the Gothic characters or any other strange ones, they could be picked out later at the same time a literal translation was being changed to an idiomatic one.

Mr. Kosarin: It has been considered. Readers of one kind or another are under development in many places. A reader that can take almost any kind of character or symbol so that only one operation is necessary is a long-range goal.

Mr. Kreuzer: Obviously it wouldn't be one operation today but perhaps it would only mean that you'd have to go back a few times just as you'd go back to change the literal translation into a semantic or idiomatic one —I think in many cases this would speed up operating time.

Approaches to the Reduction of Ambiguity in Machine Translation

By L. E. DOSTERT

Four basic approaches to the resolution of transfer-ambiguity are reviewed: (1) preparation of microglossaries; (2) formulation of linguistic operations to effect structural parallelism between the languages involved; (3) establishment of categories based on semantic functioning; (4) establishment of idiom classes. Structural analysis involved in a French-English translation is examined in detail.

In research in the field of machine translation we are brought by the nature of our objective to consider languages as codes. If we accept that translation is the transfer of meaning from one language to another, then ultimately our task is to establish specific and automatic correspondence between the signs of a given language-code from which we translate (the source language), and the signs of another language-code into which we translate (the target language).

Since the signs in a given source language do not have one-for-one equivalence with those of a given target language, and since likewise there is no complete structural parallelism between the two systems, the object of research is the reduction and resolution of ambiguity in the transfer process. The word "ambiguity" here is not as precise as one would wish. To point out the problem involved more clearly the term "transfer-ambiguity" will be used in the present context.

In the case of two languages reasonably close in their lexical inventory and reasonably parallel in their structural characteristics, the reduction of transfer-ambiguity is relatively more feasible than when the source and target languages show great difference in their lexical inventories and marked divergence in their structural operations.

French and English are used in illustrating this discussion because these languages are reasonably close to each other and will be familiar to many readers.

The present objective of machine translation research aims at the translation of scientific literature. For this we have to arrive at a set of linguistic formulations, expressed in forms intelligible to a monolingual programmer, susceptible of reformulation in programming terms, and adequate to effect machine translation of scientific and technological writings.

In Georgetown we have recognized four basic approaches to the resolution of transfer-ambiguity:

(1) preparation of microglossaries;

(2) formulation of linguistic operations to effect structural parallelism between the languages involved;

(3) establishment of lexical classes or categories based on semantics functioning;

(4) establishment of idiom classes.

Microglossary Approach

The microglossary approach relies upon the assumption that a given lexical item in the source language may have different equivalents — i.e. will translate into several separate items — in the target language when used in different disciplines. To illustrate, the noun *deck* used in a maritime context will have a different equivalent in French than when used in a text dealing with computers. Or the noun *la cour* in French will translate one way into English if used in a legal document and in another if used in a treatise on architecture. Likewise, the French noun *le sujet* will be translated normally as *person* in a legal context and as *subject* in a context dealing with grammar. Conversely the English noun *object* used in a grammatical context will translate as *complément* and in general context as *objet*.

The microglossary approach seeks to resolve these types of ambiguity by proposing the compilation of separate glossaries specific to individual disciplines with each source item having the minimum possible number of equivalents.

It should be pointed out that useful as the microglossary approach may prove to be, there are cases where it will not be effective — for instance when a word like *range* used in a text having to do with artillery can be ambiguous in the source text. At present, partial microglossaries have been processed for Russian-English in physics (Michigan) and in organic chemistry (Georgetown); and in physics for French-English (Georgetown). Only more advanced and much more complete research and experience will enable us to determine the extent to which microglossarization will be helpful in the reduction of transfer-ambiguity.

Structural Analysis

Structural analysis involves the establishment of correspondence between the grammatical operations of the source and the target languages. It operates on four levels: first, on the morphological level; second, on the syntagmatic or phrase group level; third, on the syntactic or major sentence component level. It can also be said to operate on what can be called the word-class level. To illustrate this last level, the item *object* used as a noun will have a different equivalent in French than if used as a verb. The morphological, syntagmatic and syntactic techniques in the structural approach are illustrated by the following French statements for French-English translation.

List of French Statements

1. Nous parlons.	We speak.
2. Parlons-nous?	Do we speak?
3. Parlons.	Let us speak.
4. Nous nous parlons.	We speak to each other.
5. Nous parlons-nous?	Do we speak to each other?
6. Parlons-nous.	Let us speak to each other.
7. Parler.	To speak.
8. Le parler.	The dialect.
9. Sans parler.	Without speaking.

The item *parl-*, stem of a French regular verb in group I (-er) has been entered in the stored dictionary, with its equivalent *speak* in English. Upon receiving the input item *parlons*, the machine identifies it in terms of stem and suffix. The operations then occur for sentences 1 to 6 as indicated in Fig. 1.

The stem having been identified, the morphological analysis then begins. The identification of the suffix *-ons* is the result of a series of consecutive no-yes decisions, thus: is it *-er* (infinitive); if not, is it *-ant* (present participle); if not, is it *-é* (past participle); if not, is it *-e* (1st person sing., pres. indicative); if not, is it *-es* (ditto, 2d pers.); if not, is it *-e* (ditto, 3d pers.); if not, is it *-ons* (1st pers. plur. pres. ind.). Having concluded the analysis on the morphological level, the next steps will be on the syntagmatic or on the syntactic levels.

By the word *item* we designate in this case the word which is the fulcrum of the analysis. By *item* -1 we designate the immediately preceding word (in left-to-right reading); by *item* $+1$, we designate the word immediately following.

The diamond-shaped figures in Fig. 1 represent the consecutive yes-no questions. The rectangular boxes represent the decision arrived at by the following steps:

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Is item -1 a p. p. 1 p^1 (pers. pronoun first person plural nominative); if not, is it p. p. 1 p^2 (ditto, reflexive); if yes, is item -2 p. p. 1 p^1? If yes, decision is "We speak to each other," or No. 4 in the list. If item -2 is not p. p. 1 p^1, is item $+1$ *−nous*, or hyphen + p. p. 1 p^2? If not, is item $+2$ a period? If yes, decision is *We speak*, or sentence No. 1. If item $+1$ is p. p. 1 p^2, and item $+2$ a ?, decision is "*Do we speak to each other*?" or No. 5 in the list. If item -1 is not p. p 1 p, and item $+1$ is p. p. 1 p^1, and item $+2$ is ?, decision is *Do we speak?* or sentence No. 2. If item -1 is not p. p. 1 p; and if item $+1$ is not p. p. 1 p, decision is *Let us speak*, or sentence No. 3 on the list. If item -1 is not p. p. 1 p, and item $+1$ is p. p. 1 p^1, and item $+2$ is *period*, the decision six occurs: *Let us speak to each other*.

A brief analysis of numbers 7, 8, and 9 in the list shows that: If suffix is identified as *−er*, is item -1 a prep. 1 (preposition, group I); if yes, translate the preposition and take decision No. 9, *without speaking*. If item -1 is zero, take decision No. 7, *to speak*. If item -1 is d. a. m. s. (definite article, masculine singular) decision No. 8 is taken, *the dialect*.

The formulation is susceptible of general application to nearly all French verbs and it handles the fundamental structure of declaration, interrogation, and command, and operates on the transitive and intransitive levels, as well as on the pronominal and noninflected levels.

Semantic Categories

The establishment of semantic categories (sometimes referred to as lexical classes) is the least-charted area of machine translation research at this point. It involves the establishment of subclasses of major word classes (mainly nouns, verbs, adjectives and prepositions) based on the semantic function of the item. It calls for the resolution of ambiguity on a nonstructural basis, and without recourse to microglossarization or idiomatization. It involves the search for cues outside the morphological and syntactic levels.

The following example will illustrate the point:

The English statement, "Put your book on the table and put your sentence on the board," will call for a different translation of the preposition "on" in French. The first occurrence has to be translated by the French preposition "sur" and the second by the French prepositional article "au." The examination of the contextual environment will yield no clues in terms of structural data. Thus, the ambiguous item is preceded by an identical verb, by an identical possessive, and is followed by a common noun. Further scrutiny will reveal that both nouns can be classified as "nouns of surface" and that in the case of "table" the surface is *horizontal*, whereas the "blackboard" is normally thought of as being *vertical*. A similar context will yield a similar result. Thus, "Put your hat on the chair," will yield, "*sur* la chaise," and "Hang it *on* the wall," will yield "*au* mur."

A further illustration is represented in the sentence, "Pour a little acid in a little beaker." The item "little" functions here as an adverb in the first instance and as an adjective in the second instance. The determination of its grammatical function, however, can only be deduced from the fact that in the first instance we are dealing with a noun of *bulk* and in the second we have what can be called a noun of *unit*.

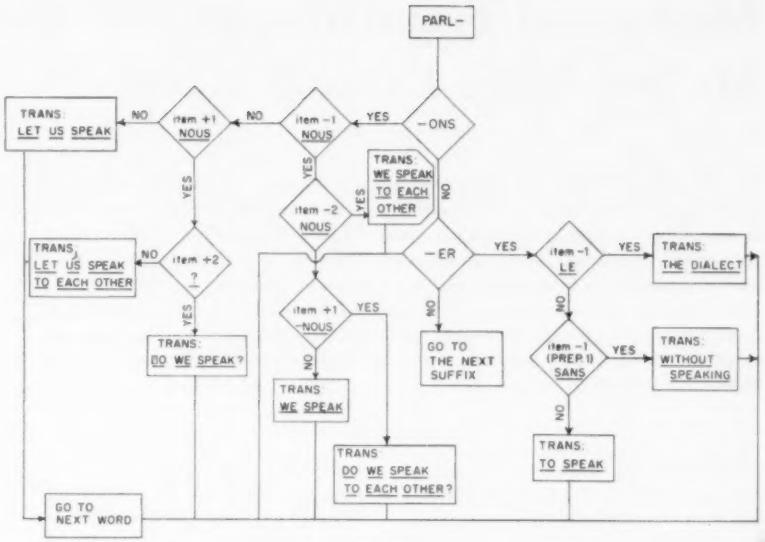

Figure 1

There is a class of ambiguity which cannot be resolved readily and that is when a single item in the source language has two distinct equivalents in the target language. Thus, for example, the English word *experiment* is rendered in French by *expérience*, but so is the English word *experience*. Thus, the sentence, "L'expérience a démontré . . ." could yield both, "The experiment has shown," and "Experience has shown." Since in French the article is present in both cases, no clue can be found within that context. The tentative solution to such a situation is to take the English equivalent *experience* alone and use it in all instances, even when *experiment* would be more accurate. The measure of ambiguity would be minimal. Even the use of *expériences* in the plural will not yield an absolute clue for the choice of either *experiences* or *experiments*.

Idiomatization

The establishment of idiom classes is self-defined. An idiom is a cluster of items nontransferable as separate units. Thus, in isolation *right* will have a variety of equivalents which will not be acceptable in the cluster *right away*, which is treated in machine translation not as two items, but as a single lexical unit.

Mechanical Translation by the Thesaurus Method Using Existing Machinery

A. F. PARKER-RHODES
and C. WORDLEY

The thesaurus method of machine translation is designed to provide a means of obtaining the best translation of a word in a given context by defining every word in terms of the context in which it can occur. These definitions can be represented by elements of a lattice. By operations on the elements representing the words of a text, it is possible in principle to derive a new set of elements (a) which together carry the same information as the input set; and (b) each of which corresponds to some word in the given target language. Work is proceeding on practical methods of programming such procedures using (a) punched-card equipment and (b) digital computers.

Most of the work done hitherto on machine translation has been based on the hope that both semantic and syntactic problems could be solved by a set of binary decisions. That is, it was hoped that the problem of finding the right rendering of a given word in a text into a word of a given target language could be solved by deciding between a fixed set of choices according to a fixed schema of questions relating to a manageable number of adjacent words or structures. Experience shows that whenever such methods have been tested adequately, that is on unselected material not itself used in the preparation of the dictionary entries which the procedure requires, only low-level translation has been achieved. The value of low-level translations of this type varies greatly with the nature of the target language. In a highly inflected language indifferent to word-order, such as Russian, this level of translation may be of some practical use, but with English as the target language it tends to be too great a strain on the reader to understand what is being said for it to be acceptable.

Accordingly, the work of the Cambridge Language Research Unit has been based on the attempt to construct an adequate theory by means of which this basic translation problem could be solved in a more fundamental manner than by inadequately generalizable choice-procedures. It has also been our belief that any theory really capable of solving the semantic problem would also be applicable or at least adaptable to the problem of syntax transformation as well. The thesaurus method, with which our name has come to be associated, is the outcome of our search for such a theory.[1]

When asked, "What is a thesaurus?," the simplest answer is to point to some literary thesaurus, such as the well-known Roget,[2] and say that a thesaurus is any system of classification of words of a language of this form and type. For those who are not familiar with such works, they may be described as inverted dictionaries; whereas in a dictionary one looks up a word and finds its meaning, defined typically by a list of its possible uses, in a thesaurus one starts from some indication of what one wants a word to mean, and from this indication the thesaurus leads one to a word or selection of words which will express the desired meaning. Essentially then a thesaurus, like a dictionary, is a means of defining words in terms of their possible use, but the arrangement of the two works is on opposite principles.

The mathematician will appreciate that a thesaurus thus defined may be regarded as a method of encoding the meanings of words. It is arranged under a number of "heads," each of which contains words which have in some sense a similar meaning. In practice, the heads can be regarded as contexts; all the words listed under one head are capable of occurring in the same context, or at least set of related contexts; since these contexts are essentially extra-linguistic, the system is in principle interlingual. The thesaurus is capable of distinguishing between words which occur under different selections of heads; it does not make any distinction between two words which are given under the same set of heads. It follows that the thesaurus definition of a word can be represented as a sequence of binary digits the same in number as the heads of the thesaurus, each being a *1* if the word occurs under the corresponding head and a *0* if it does not.

The number of these heads in Roget's Thesaurus is 1000. In other works of the kind (there are remarkably few in any language) comparable numbers are found. It would seem to follow that a useful (but not necessarily sufficient) distinction between the words of a language can be made by assigning to each word a symbol of 1000 bits. It is therefore possible to take as the first step of a translation procedure the replacement of each word (or part of a word, for the principle is equally applicable to affixes and other word-components) in the input text by one 1000-bit symbol, and to expect that its semantic properties will be fairly adequately represented thereby.

The Thesaurus as a Lattice

This device immediately suggests that a thesaurus might be regarded as a lattice; and moreover that it could be *explicitly* interlingual. The set of all possible 1000-bit symbols constitutes the Boolean lattice of order 2^{1000}, under the ordering relation that an element a includes an element b whenever every *1* in the symbol of b corresponds to a *1* in that of a. The elements of this lattice which correspond to actual words of a given language will not be all of these of course (the vast majority of possible symbols will not represent words in any language: remember that 2^{1000} is an exceedingly large number); but they may form a sublattice of it, and can in fact be made into a lattice by the addition of entries, all of which can be equated if not with single words at least with phrases, except for one element representing a word of *completely indeterminate meaning* and one representing a word of *null meaning*; these are the top and bottom elements of the whole lattice. The value of this construction is that if the thesaurus can be represented as a lattice, the methods of lattice algebra can be called upon to devise algorithms with which to handle the material.

As a simple example, consider the two English sentences, "He's been working on that problem for two months," and "He's been working on that site for two months." The word *working* carries a different meaning in the two cases, and if either were to be translated into some other language it would in general be necessary to know which of the two meanings was operative. A thesaurus will have, among many others, heads relating to *manual labor* and *intellectual labor;* the word *work* (and of course its inflected forms if these are to be separately listed) will itself occur under both. The fact that in the first sentence we have the word *problem* can be made use of to select the head *intellectual labor*, in such a way that in the symbol which we find for the translation of *working* there will be a *1* in the place given over to this head, but a *0* in the place assigned to *manual labor*. Likewise, the opposite arrangement would be produced by the same procedure on the second sentence, because there we have the word *site*, which will occur under the *manual labor* head but not under *intellectual* head.

Presented on October 23, 1958, at the Society's Convention at Detroit by A. F. Parker-Rhodes (who read the paper) and C. Wordley, Cambridge Language Research Unit, 20 Millington Rd., Cambridge, England.
(This paper was received on October 2, 1958.)

Of course, this is an extremely simplified case; but the selection of the appropriate heads, once we have decided what words belong together and how we are to bring them into the calculation, is an extremely simple operation. If all the cases we come across can be reduced to a sequence of such operations, even if very many of them are required, then we shall have an essentially simple procedure for getting at the translation of each word in any input sentence. In particular, if this is how we are to handle the effect of context on the translation of words, we can handle any amount of context (i.e. any number of neighboring words) with equal facility, and moreover by performing the operation in appropriate stages we can represent in our procedure whatever details of the syntactic structure of the input text we find it necessary to carry over. There is, therefore, reason to expect that the method may be a very powerful one, if it can be conveniently mechanized.

The Problem of Syntax

It is convenient to treat the processing of the syntactic and semantic parts of the translation process separately, though they are intended ultimately to be integrated into a single process. We are still uncertain as to the best way of handling syntax, but the choice broadly lies between reducing the syntactic information recorded in our dictionaries to an absolute minimum, consistently with being able to ascertain, when necessary, the grammatical structure of any passage; and attempting to assimilate the grammatical structure to the pattern of thesaurus heads. That the latter may be possible is suggested to us by the fact that word-classes such as nouns or prepositions may be defined, at least approximately, by reference to the sequences of word-classes in which they can occur, that is, in a certain sense, by the contexts in which they occur, which is the same principle that the thesaurus uses to define semantic properties of words.[3] However, working out this idea in practice is difficult, and we have made more progress with the other method, of setting aside the minimum number of bits of information to determine syntactic behavior.

Investigation at the linguistic level has shown us that a very simple classification of word functions may be attainable which is both sufficient to infer the complete sentence structure from, and valid for all languages, at least with the help of comparatively few special rules regarding word order, etc. Roughly, we classify words first between noun-like and verb-like functions, and next between principal qualifiers and secondary qualifiers; these terms being defined with sufficient rigor to make the dictionary entry determinate and not subject to personal opinion. We also recognize not only a word's own function, but note whether its occurrence is confined to larger groups of definite function as well. Thus, a relative pronoun is not only a word of noun-like function, but it always belongs to a group (the relative clause) which has a qualifying function for another noun. We also require to use information regarding the place of a word in its group when this is available. Thus, we distinguish initial words (prepositions for instance), final words (like the English possessive *'s*), etc.

To deal with the cases, numerous in some languages, where words show ambiguity of function even when this is reduced to such a simple scheme as we have described, we also recognize a series of indeterminate word-classes. These, together with the basic terms indicated above, make the syntax classification itself a lattice. This not only means that it can be treated in the same way as the semantic material (and ultimately, we hope, simultaneously with it), but also makes it possible to calculate, in a simple manner, the function or range of functions possible to any word group, when we know those of the separate words in it. The necessary operations are of the same kind as those used for manipulating the semantic thesaurus.

The procedure in applying this method is as follows. First, we use the word-function indications present in our dictionary readings for each word to work out the structure of each sentence. The rules for doing this are quite simple, provided that not too many ambiguous functions occur; when they do, it is necessary to eke out the general rules with rules based on word order and word combinations which are peculiar to each language. There is no reason to doubt that this will always be possible, but we don't yet know whether the procedure may not be too slow to be useful in some languages. The structure that we work out at this stage can be conveniently represented as a system of brackets. For instance, the English sentence "I thought you had seen me" has the bracket structure (I (thought (you ((had seen) me)))), or more briefly (A(B(C((DE)F)))). In practice we probably don't need the whole of the bracketing pattern; we certainly need to know at least the limits of clauses, because these provide, in most cases at least, limits of relevance of particular contexts, and are therefore needed to provide boundary conditions for the thesaurus operations. Once a structural group has been identified, the next step is to apply the thesaurus procedure to the words within the group, and thus get out specifications for their translation in terms of list of heads to which each word in the output text ought to belong. Meanwhile we also work out, from the function indications attached to each word on the group, what the function indication of the whole group should be, and (at the same time) provide a collective specification, being the list of all the heads that any of the words occur in, which we may be able to use to translate the group as a whole. This makes it possible to transform groups of words in the input text into single words (or at least single dictionary units) in the output, which in turn makes possible the translation of idiomatic phrases, and may have wider implications also. We are not yet able to say, however, how much of this method can be claimed as truly general.

The Use of Punched-Card Devices

The fundamental operation in using a thesaurus method of translation (irrespective of the detailed structure of the thesaurus) is that of selecting the heads common to two word-symbols (or symbols constructed by previous operation from the input text). This is an elementary Boolean operation which can be realized very readily by means of punched cards. If each head is represented by a place on a card, and if presence of a word in the head (represented by a *1* in binary notation), is represented by punching a hole in that place on the card representing the given word, then this fundamental operation is effected by merely superposing the two cards concerned, and treating the resultant pattern of holes as if it were punched on a single card. The actual handling of the cards is of course a time-consuming operation; but we shall nevertheless proceed with the exposition as if it were all to be done by hand, because this makes the procedures easier to visualize and to follow in the mind. In real life, various devices can be employed to speed up the operations, but these need not be considered here.

It must be emphasized that this is to use the punched-card equipment as a calculating device, even though the calculation is of a mathematically trivial character. It is a different kind of application of the apparatus from that in which punched cards are used as clerical aids, for example in actually compiling the dictionaries which we shall need. For the purpose of clerical aids punched-card methods will always have a place in machine translation; but as calculating devices their future is less clear.

We shall now turn to consider in more detail the sort of translating procedure we have been working on.

Our punched-card program "presupposes an unlimited time and an unlimited space."[4] This is mainly due to the inadequacy of the machines in existence to deal with the types of coding on the punched cards. The four types of machine needed for the program, as it is at present, are a hand punch, a duplicating punch, specially adapted to make "meets" and "joins," a sorter and a collator. (A "meet" is a card with all the holes which two or more cards have in common, and a "join" is one with all the holes two or more cards have on them.) It is thought that the soundest nucleus for the automatic project on punched cards would be

a twin-feed card comparator, and reproducing punch, together with a collator, rather than a sorter, for marshalling and selection.

A brief outline of the punched-card program with the machines used at various stages follows.

In the program as it stands now there are three permanent dictionaries needed for the thesaurus method of translation. Two of these dictionaries are in the form of punched cards, while the other is in the form of an ordinary dictionary, i.e. alphabetically ordered and in book form. These three dictionaries are called (1) the "chunking reference dictionary," (2) the "input language dictionary" and (3) the output language "fan" dictionary.

The chunking reference dictionary consists of the words of the input language alphabetically, in the manner in which they are split up and the number of possible meanings they may have. The words of the input language are usually divided into stems and endings. The stems are further split when the chunks thus obtained have some semantic meaning. Each chunk in input language may have various meanings; these must be noted to enable the correct number of input cards to be generated. Then all the various possibilities will be drawn from the dictionary. This chunking of the input language will make the input language dictionary smaller, when it is completed, than it would be if it were to consist of input language words.

The input language dictionary consists of cards, one for each chunk in the input language. These cards have the following information on them: *semantic* heads, *syntactic* classification, supplementary information peculiar to the given language; and the *coded spelling* of the word. The semantic heads are taken from a special "compacted" thesaurus, since Roget has 1000 heads whereas we have room for only 780. This semantic information takes up columns 1–78 on rows 0–9 of the card. The syntactic information is coded on the card on the second row down from the top of the card. The monolingual information on the chunk dictionary cards is the information pertaining to the declension, conjugation, gender and singular and plural.

The fan output dictionary has on each card the set of output words which belong to the heads punched on the card. These entries cover the total fan of uses that the ouput word can have in the target language. This information is coded in the same manner as the semantic information on the input language dictionary cards.

The input text is chunked clerically with the aid of the chunking dictionary. The chunks of the text are then numbered by reference to the paragraph, sentence and word. This numbering is called the text position indicator coded in 21 bits as a binary numeral. The chunks are also numbered in the sequence in which they occur in the text. The coded spelling for each chunk is then worked out. This spelling is in the form of a compressed binary coding of 20 bits. This coding is punched in columns 79 and 80 in rows 0–9. The above information is then punched onto a pack of cards, called the input pack; it will be in the order of the input text.

To enable the relevant cards to be drawn from the input language dictionary, the input pack must be ordered alphabetically. The ordering of the pack is carried out by a series of sorts operating on the coded spelling. Then by means of a single collation on the coded spelling, with the input cards in one of the collator feeds and the dictionary in the other feed, all the cards relevant to the input cards may be drawn out.

The dictionary cards are copied by the reproducing punch and the original dictionary cards returned to the dictionary. The dictionary cards and their equivalent input cards are then joined to form a pack of cards called the second dictionary pack; this is then restored to the original text order.

This second dictionary pack contains all the information needed to carry out a thesaurus translation procedure.

Some of the input chunk cards will have drawn out more than one card for some of the input text chunks, from the dictionary. The next step in the procedure is to remove the cards which do not apply to the piece of discourse under consideration. This is called the "pun-removal" procedure. It is intended to deal mainly with ambiguous endings. Intersections are made on the monolingual information on the cards. These intersections are intraword intersections, and will remove nearly all the puns. In some cases this procedure will not suffice; e.g. in Latin it cannot distinguish between the ablative and the nominative uses of the ending $-a$. Therefore when some chunks are still ambiguous, intraclause intersections must be made on the semantic entries on the chunk cards. The card of whose holes most survive these intersections is retained, and the others abandoned. If more than one card still remains for any chunk these cards are all abandoned, as it is better to lose too much information than to retain incorrect information.

The input text is then sorted into the clauses which make up the input text. Then a series of parallel operations are carried out on each of these clause packs.

The first of these operations is to find the frequency of the semantic and the syntactic heads in these clauses. This is carried out by a series of meets and joins. This operation is carried out on the adapted reproducing punch. When the heads that have occurred more than a certain number of times have been obtained for each clause, then a card for each clause is punched with the most frequent head holes on them. These cards are called the head grid cards.

The next stage in the procedure is to form word cards from the chunk cards. This is simply done by making meet cards for the chunks of each word. Then with the head grid card a further pack is generated, which is the meet of this card and each of the word cards.

The fan output dictionary is then sorted for each word card. This consists of sorting the fan dictionary n times, where n is the number of holes in the word card. The card chosen for each word card will be that card which has the nearest pattern of holes in it to the word card. This card will give the translation of the input word. These words are written on the fan cards chosen.

The sorting in the above procedure is the time-consuming process, and this could be shortened considerably if face-reading machines were available instead of the column-reading machines as they are at the present time. An example of this time factor is that the sorting of the second dictionary pack back into the text order would take a maximum 27,756 sorts.

Each stage in this procedure may be tested separately and perfected without running the complete procedure through the machines. The final version of the punched card procedure may easily be transferred on to a digital computer, as the complete set of punched-card machines constitutes such a computer.

Computer Programs

It will be realized that this procedure, carried out manually with actual cards for an actual text, is very laborious and slow. It is not intended that a practicable translation method be in this form. Its value is however twofold: on the one hand its practicality would be much enhanced by relatively minor advances in punched-card technology, and on the other hand by its very slowness and step-by-step quality it serves admirably as a preprogramming method for digital computers or any other calculating devices we may want to use. Naturally, when one comes to write actual digital computer programs for achieving the same results as are achieved by the punched-card program just described, there appears to be a radical reshaping of the whole procedure because the "housekeeping" operations required by the two methods are totally unlike. In the punched-card procedure these consist mainly in tedious copying operations which have no counterpart at all on a digital computer which, however, spends much of its time in counting items and recording and reading the resulting serial numbers.

A main object of our research has been to find out, and this is largely an empirical matter, what sort of variations in the procedure are the most profitable to

make, and what parts of it are most often the seat of failure. The punched-card method is especially valuable in that it makes easy the necessary breakdown of the procedure into portions which can in this way be separately examined. Digital computer programs are however a much more convenient way of testing completed procedures, because they make possible runs on realistically long passages. Moreover, they go through fast enough to be within sight of commercial targets of speed, so that we are justified in claiming that any procedure which stands up to such testing on a computer would be a reasonable basis from which to advance to a fully salable translation technique.

The one great barrier to straightforward conversion of the punched-card procedure we have described to a form acceptable on a digital computer is the fact that the cards assume, in effect, a word-length of up to 860 bits, which is far beyond the capacity of any existing computer to handle otherwise than by slow multilength methods. If it could not be overcome, this fact would shut us off from the desirable prospects of really fast procedures suggested above. Fortunately we have good hopes that this particular difficulty can be satisfactorily surmounted.

The manner in which we propose to do this is to use a much more economical encoding of the information than the simple procedure of assigning one bit in each computer word to one place on the card. That such economy is possible, without confounding the information (which for mechanical translation purposes is at best marginally admissible) depends on the statistical properties of the lattice by which the thesaurus is represented.[5] By means of a sampling technique applied to *Roget's Thesaurus*, we have found that the information contained in the index of the standard edition of that work can be represented by a lattice whose degree is about 37; that is to say, that this lattice can be contained in the Boolean lattice with 2^{37} elements, and its elements therefore represented by symbols of 37 bits each. A thesaurus made adequate for translation purposes by the addition of extra entries and special heads, as for instance to represent syntactic relations, would of course be larger, though its degree would be increased relatively slightly in comparison with the number of elements which would have to be added. Nevertheless, we judge it to be unlikely that one could not encode a workable thesaurus in 60 bits, and virtually certain that 100 bits would more than suffice for any foreseeable thesaurus to be used for mechanical translation. These figures, though somewhat in excess of what current commercial machines provide for, are not absurd as a target for the future (which 1000-bit words may be). Moreover, we can test all our programs, at the sacrifice of only a part of their quality, on existing machines providing for handling 40-bit words.

The actual procedure for encoding the thesaurus is somewhat elaborate, and is the subject of a paper soon to be published.[6] The operation is one requiring a computer, but being a thing done once for all one can in principle afford to give it an hour or so of machine time, which is what it is likely to require. The output of the procedure is to assign to each head of the thesaurus, in place of the serial number which originally identifies it, a 40-bit symbol which will represent it in the encoded form. The code sign for any word in the input or output language can then be formed from the corresponding punched card by taking the head symbols corresponding to every hole in the card and forming their Boolean join. Join and meet operations on the resulting symbols will give results the same as would be got from the same operations on the untreated 860-bit symbols; in this sense there is no confounding. It must be emphasized however that any new entry added to the thesaurus, and thus also to the input or output dictionaries, after the encoding has been completed, will introduce confounding, and on such a scale that the new entry will in fact be unusable. The coded thesaurus must therefore be regarded as a closed system, amendable only by going through the encoding routine all over again.

Another point in the procedure where a good deal of research has been required to obtain efficient programming on digital machines, is at the output stage, represented by the fan dictionary in the punched-card procedure. In a machine handling actual cards there are various methods of sorting which will quite quickly find the card or cards having a particular pattern of holes on them, and thus serve as sorting procedures on the output dictionary. This is especially easy if edge-punching can be used. But to find, in the long-term store of a digital computer, a given entry identified only by certain features of its content is liable to be very slow (at any rate on the timescale to which programmers are accustomed). We have therefore given some thought to problems of programming this type of operation. The problem turns out to be again essentially one of coding. It appears that the minimum search time required depends very markedly on the shape of the lattice representing the thesaurus, and by good fortune the optimum shape turns out to be one in which the height of the lattice (length of longest chain) is small compared to the number of elements; this is in fact the shape that the thesaurus lattice happens to be. As a result of this, the time required for the output stage of the completed program is likely to be, if anything, less than that required for the initial dictionary look-up. We have not yet however tested this part of the procedure in actual machine runs.

We are still only just beginning our program, of testing variations on the basic procedure on digital computers, so we cannot yet say what the results will be. There is every prospect, however, that mechanical translation by the thesaurus method will be successfully accomplished. We can also say that, with certain qualifications, it should be feasible, using only machines of existing type. The main qualification is that existing memory devices are either too small or too slow to make a fully mechanized translation procedure an immediate commercial prospect. However, advances in this field are being made so rapidly that this reservation may at any moment cease to be valid.

A word of caution may however not be out of place in conclusion. Even though in principle mechanical translation using machines existing or soon-to-exist may be possible, it has never yet been actually realized. The demonstrations which are given from time to time have hitherto been essentially demonstrations of mechanical dictionary searching, helped out by simple reordering techniques. Results achieved on selected texts cannot be reliably reproduced on unselected (i.e. randomly chosen) texts in the chosen language, even within the same subject or style. True machine translation will not have been achieved till a readable and understandable translation of a genuinely unselected and unpre-edited text has been produced. And before this is done much theoretical and practical work remains to be accomplished.

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5. A. F. Parker-Rhodes and R. M. Needham, "Encoding Roget's Thesaurus," Cambridge Language Research Unit, 1958.
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Discussion

Max Kosarin (Army Pictorial Center): What language or languages have you been experimenting with?

Mr. Parker-Rhodes: We plan to be able to cope with any of the major languages of the world. We started with Chinese as the simplest in structure; from that we went over to the opposite extreme and experimented with Latin (we would have preferred Russian but we haven't enough people available to do that — that being one of the vagaries of the British educational system). We have also done a bit on Italian, and we have being prepared for us an Italian dictionary on which we propose to test a modified form of this procedure right now — it should be starting this year.

Automatic Printed Character Reading

By BOWMAN SCOTT
and PETER A. M. CURRY

There is a need for automatic character recognition in business data processing systems and a particular method of reading has been chosen. A description of the method also points out the facilities for overcoming the defects of ordinary typescript.

PRINTED CHARACTER recognition devices have been the subject of various research and development programs for more than a decade, and for nearly five years Solartron Electronic Ltd. has been concerned with this section of automatic processing. The main line of development has been in the direction of a high-accuracy system for feeding computers.

Character Recognition

The first six months of the development program described in this paper was spent, for the most part, in studying print styles, quality and positional tolerances. At a very early stage it was recognized that there are great differences between the ideal character and that achieved in practice.

Figure 1 is an S, considerably magnified. There is no sharp boundary to the character. The limb width varies, bits are missing, there is dirt around it, the paper appears dark gray in several places, and the character can be badly misaligned. If a machine is to perform satisfactorily it must be able to read this type of character, which is produced by a printing mechanism designed to be economical to manufacture.

Presented on October 23, 1958, at the Society's Convention in Detroit by Bowman Scott and Peter A. M. Curry, Solartron Electronic Business Machines Ltd., Victoria Rd., Farnborough, Hampshire, England.
(This paper was received on February 19, 1959.)
Edit. Note: The authors' version has been somewhat abridged for the *Journal*.

Fig. 1. The letter S, magnified, showing no sharp boundary, varied limb width, bits missing and dirt around it.

Most systems of character recognition are based on dividing the character into a number of successive lines or areas in which a decision is made as to the amount of black or white. This information is then passed to a processing system designed to recognize and discriminate between different characters.

The two major systems under development at the present time are magnetic character recognition and optical character recognition. In the magnetic system the document, with characters printed in magnetic ink, is passed under a reading head which is a narrow gap in a magnetic circuit. The variations in the magnetic circuit are then measured electrically and the information processed to enable the characters to be recognized. The scanning motion in one direction is provided by the movement of the paper, and in the other direction a measure is made of the average intensity of the characters in each vertical line.

Optical character recognition is based on scanning each character with a flying spot of light which may be generated on the face of a cathode-ray tube or moved by an optical system. Since the character is being scanned with a spot rather than a long gap it is possible to discriminate between areas of black and white within each vertical line into which the character is divided. At present it seems that this approach offers a much higher effective resolution since with the considerable variations in intensity of printing the positional significance of black and white in the vertical direction is of considerably more value than a summation of the intensity within each vertical column. The use of this positional significance in vertical direction does, of course, emphasize the need for a system which will take up misregistration in the vertical plane.

The Solartron ERA has been designed to accept moderate quality impressions and to recognize these at a speed of approximately 250 characters/sec with a high degree of accuracy. The character to be read is scanned along 16 vertical lines, using a flying-spot scanner, with the image of the raster focused onto the character by means of a lens (Fig. 2). As the spot traces out the raster, the reflected light signal from the paper is picked up by a photomultiplier cell which converts the light variations into electrical variations. A typical electrical signal for one line of the raster is shown in Fig. 3.

The top pulse trace shows the effect of mutilation and dirt around the character. By clipping the signal at a predetermined level a sharp white/black boundary is obtained for each character. This process is automatic and the actual level is varied according to the quality of each character. This often enables us to read through quite fantastic degrees of mutilation such as, for example, rubber over-stamping on bank checks.

In actual practice characters which are formed from carbon impressions include a very large amount of dense black carbon particles separated by varying areas of white. Since we know the minimum width of any limb of the character we are able to insert pulse width discrimination so that we reject minor areas of dense black, but retain areas which are con-

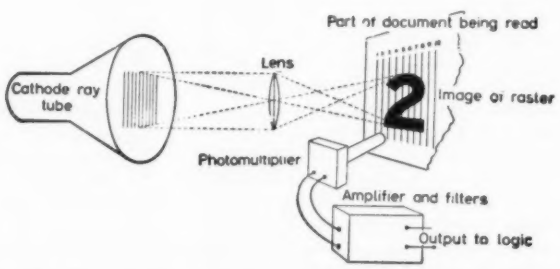

Fig. 2. Character to be read, the number 2, is scanned along 10 vertical lines [in the pilot model] using a flying-spot scanner. A lens focuses the raster image onto the character.

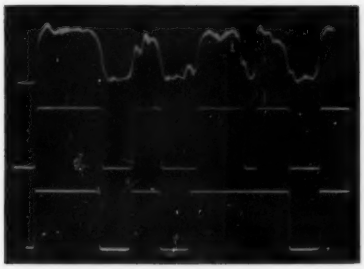

Fig. 3. Typical electrical signal for one line of the raster.

parable with the expected width of the lines from which the character is built up.

In practice the raster is small compared with the tube face. By moving the raster, characters can be read along a line without moving the document sideways. This advantage of a cathode-ray tube coupled with the control of the scanned area for character misalignment, allows the machine to search for and recognize the character in a very short period (about 1/250 sec). In order to allow for considerable misalignment in the vertical plane each line of the raster is broken up into twenty-eight bits, the height of each character being covered by about fourteen. The information from the scanned area is fed sequentially into two parallel stores, one for black and one for white.

A typical position of two characters in the store is shown in Fig. 4. The columns A to T represent the scan lines across the character and the positions 1 to 28, storage elements in each column. The recognition is achieved by combining the storage element outputs through a series of and/or logical decisions which enable maximum use of the significant information available. To illustrate this, differentiation of the characters 2 and 8 can be obtained by the areas D 13 and R 18. When both these areas are black plus certain other conditions a decision for 8 would be obtained, while the converse condition of these storage elements plus similar conditions would produce a recognition signal for 2.

The "and" statements are used to define characters which are free from imperfections. Cells D 13 and R 18 can be backed up by other appropriate logic to overcome a smudged 2 or a mutilated 8. The "or" statements give additional flexibility. For instance, instead of just requiring the areas D 13 and R 18 to be black for 8 and white for 2, the statement can be D 13 or D 14, or C 12 or C 13; and R 18 or R 17, or P 16 or P 17 must be black for 8 and white for 2. This allows for a certain amount of mutilation, smudging and misalignment. By the selection of suitable logical connections of appropriate areas it is possible to differentiate one figure from any other. If the signal obtained does not conform with any character the machine signals a reject. It should be stressed that the logic is not forced to make a decision. The actual procedure for a reject will, to a certain extent, depend on the output mechanism being used. However, when a reject occurs, the output from the reader is used to take appropriate action.

Identification of a character is signalled out by a pulse on a wire, one wire corresponding to each character. This signal can be used to operate a card punch, tape punch, sorter, magnetic-tape unit or fed to a computer through suitable linking circuitry.

In the initial production models, the input to the reader takes the form of a mechanical handling device for feeding rolls of paper very accurately past the scanner. This type of input was adopted, as were the initial applications, for reading detail rolls from cash registers and ticket issuing machines. Current development indicates that the ERA will soon be reading from separate documents.

Applications and the Future

The first production model of ERA read the characters 0–11, a plus sign and eight selected letters of the alphabet. It is to be used by a company operating a large number of multiple stores to read cash-register rolls. Another application of the continuous-roll reader is in traffic-control analysis.

With the continuous-roll reader well into production, there is increased emphasis on other developments in the field of character recognition. There is a very strong demand in the business field for a reading machine which can take information from separate documents, and a contract has been entered into for development of such a device. There are plans to link ERA to a document-handling machine manufactured by a specialist in the field. Several companies in the United States and England have had considerable experience in this field, and already have machines operating effectively at rates of about 750 documents/min. There are many applications where the document speed required is far below 15/sec, and therefore the use of ERA with existing document-handling equipment is a feasible proposition.

Main fields of interest include the reading of handwritten characters and the complete alphabet. There is interest in providing a means of reading handwritten characters which may call for a highly stylized form of writing, although stylized forms of writing can prove expensive in that they slow down the work of the writer. Some restrictions must be placed on the writer in order to obtain a character that a machine can recognize. In a study of this problem,

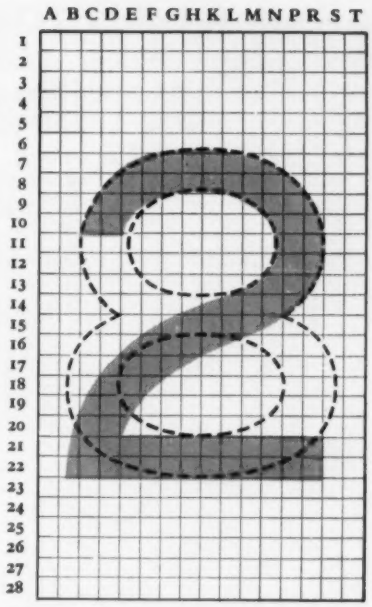

Fig. 4. Typical position of two characters, the numbers 2 and 8 in the store.

T. L. Dimond of Bell Telephone Laboratories has arrived at a logic which places fairly wide limits on the writer, and at the same time produces a character capable of machine recognition. Further developments in this field may be expected in the near future.

The reading of the complete alphabet has many applications. Perhaps the most interesting is in the field of machine translation. In all probability the translations required will be of technical articles in the form of books or magazines; therefore either each page will have to be reproduced in some form suitable for feeding, or pages will have to be turned over by an operator or an automatic mechanism. On each page there are usually a number of type styles and sizes. One possibility is that the reader will be programmed to read the more common type styles, with other characters including mathematical formulas keyed in by an operator, the reader stopping at appropriate points. The same process would apply to illustrations. It is obvious that a reader would considerably reduce the manual punching required, but a completely automatic process is not a likely prospect for the near future.

Many problems remain and the speed of their solution will depend largely on the extent of industrial investment in this field. It should be stressed that character recognition is now both feasible and economic, and must therefore become an essential part of any major data-processing installation.

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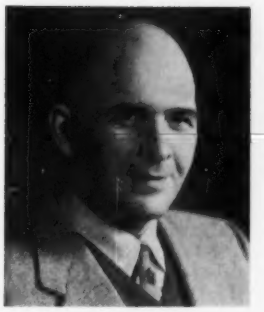

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Robert G. Hufford, *Chairman, West*, Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38
Harry Brueggemann Ub Iwerks Ralph Lovell
Arthur F. Baldwin, *Chairman, International*, National Theatre Supply Export, 92 Gold St., New York 38
Gordon A. Chambers Burton F. Perry Robert C. Rheineck

ADVISORS TO THE PRESIDENT ON EUROPEAN AFFAIRS. *To act as liaison between the Society at large and European firms, individuals and organizations interested in motion-picture and television engineering.*

Great Britain: Cornelius G. Mayer, RCA Great Britain Ltd., Eagle House, 109 Jermyn St., London S.W. 1
Continental: Karl Wurstlin, Kodak Aktiengesellschaft, Hedelfinger Strasse 56–62 Stuttgart-Wangen, Germany

BOARD OF EDITORS. *To pass upon the suitability of all material submitted for publication, or for presentation at conventions, and to control the publication of the* JOURNAL.

Pierre Mertz, *Chairman*, 66 Leamington St., Lido, Long Beach, N. Y.

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Gerald M. Best	Lloyd T. Goldsmith	Russell C. Holslag	C. David Miller	Allen L. Sorem	Charles W. Wyckoff
George R. Crane	Lorin D. Grignon	Clyde R. Keith	Herbert W. Pangborn	John H. Waddell	Emerson Yorke
Harold E. Edgerton					

EDUCATION COMMITTEE. *Assist in improving the technical training of engineers and technicians for motion pictures and television and to develop appropriate curricula in educational institutions.*

John G. Frayne, *Chairman*, Westrex Corp., 6601 Romaine St., Hollywood 38

Edward E. Benham Carlos Elmer W. E. Gephart J. W. Kaylor F. E. Pontius Edgar Schuller

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F. E. Pontius, *Chairman*, 7961 Varna Ave., Van Nuys, Calif.

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West Coast Subcommittee on Education of Laboratory Technicians
W. E. Gephart, *Chairman*, 4537 Placidia Ave., N. Hollywood, Calif.

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Theodore B. Grenier Ralph E. Lovell

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Carlos H. Elmer, *Chairman*, 410B Forrestal St., China Lake, Calif.

A. J. Carr Waldo Hunter Roy Wolford Robert L. Woltz

East Coast Subcommittee for Education of Laboratory Technicians
James W. Kaylor, *Chairman*, Movielab Film Labs, Inc., 619 W. 54th St., N. Y. 19

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Frank S. Berman	T. G. Gaski	Martin Murphy	Emmet Salzberg	C. W. Seager	R. H. Whitmore
Jack Bowen	George H. Gordon				

East Coast Subcommittee for Education of Sound Technicians
Edgar A. Schuller, *Chairman*, DeLuxe Laboratories, 850 Tenth Ave., N. Y. 19

Homer Elder	Arthur Locke	Burton F. Perry	Ben Sobin	Alfred R. Ulmer	Nathan Siegel
William F. Jordan	Haig A. Manoogian	Martin Rich			

FELLOW AWARD. *To consider qualifications of Active members as candidates for elevation to Fellow, and to submit such nominations to the Board of Governors.*

Barton Kreuzer, *Chairman*, Astro-Electronic Products Div., Radio Corp. of America, Princeton, N. J.

R. J. Beaudry	Carlos H. Elmer	Axel G. Jensen	Robert M. Morris	Reid H. Ray	Norwood L. Simmons
R. F. Birr	Lorin D. Grignon	Frederick J. Kolb	James A. Moses	Edward H. Reichard	S. P. Solow
Willy Borberg	Alan M.Gundelfinger	B. M. Loden	W. A. Palmer	Robert C. Rheineck	Ethan M. Stifle
Howard A. Chinn	Wilton R. Holm	Glenn E. Matthews	Erwin J. Pattist	A. C. Robertson	Petro Vlahos
Jerome C. Diebold	Robert G. Hufford	William R. McCown	Richard E. Putman	John W. Servies	T. Gentry Veal
Raymond B. Dull	G. Carleton Hunt				

FINANCIAL ADVISORY COMMITTEE. *To recommend to the President and the Board of Governors plans and policies relative to the Society's long-range financial needs.*

G. Carleton Hunt, *Chairman*, General Film Laboratories, 1546 N. Argyle Ave., Hollywood 28

Donald E. Hyndman — Lee E. Jones — Byron Roudabush — John W. Servies

HISTORICAL AND MUSEUM. *To collect facts and assemble data relating to the historical development of the motion-picture and television industries, to encourage pioneers to place their work on record in the form of papers for publication in the* JOURNAL, *and to place in suitable depositories equipment pertaining to the industry.*

John B. McCullough, *Chairman*, Motion Picture Assn. of America, 28 W. 44th St., New York 36

Joseph E. Aiken, Harold S. Anderson, Hye Bossin, Syd Cassyd, Walter Clark, James Cummings, R. A. Isberg, Don G. Malkames, William R. McCown, Albert Narath, S. G. Rose, Malcolm G. Townsley, A. F. Victor

HONORARY MEMBERSHIP. *To search diligently for worthy candidates who through their basic inventions or outstanding accomplishments have contributed to the advancement of the motion-picture and television industries and to propose such candidates to the Board of Governors.*

Charles R. Fordyce, *Chairman*, Eastman Kodak Co., Bldg. 26, Kodak Park Works, Rochester 4, N. Y.

Herbert Barnett — Herbert E. Farmer — Lorin D. Grignon — W. Wallace Lozier

JOURNAL AWARD. *To recommend to the Board of Governors the author or authors of the most outstanding paper originally published in the* JOURNAL *during the preceding calendar year to receive the Society's Journal Award.*

James L. Wassell, *Chairman*, 927 Harvard Lane, Wilmette, Ill.

Howard A. Chinn — Harold Kinzle — Richard O. Painter — Gordon E. Sawyer

HERBERT T. KALMUS GOLD MEDAL AWARD. *To recommend to the Board of Governors annually a candidate who has made outstanding contributions in the development of color films, processes, techniques or equipment useful in making color motion pictures for theater or television use.*

William E. Gephart, *Chairman*, General Film Labs., 1546 N. Argyle Ave., Hollywood 28

W. T. Hanson, Jr. — Hollis W. Moyse — Wadsworth E. Pohl — Lloyd Thompson

MEMBERSHIP. *To solicit new members and to arouse general interest in the activities of the Society and its publications.*

Kenneth M. Mason, *National Chairman*, Eastman Kodak Co., Prudential Bldg., Rm. 2006, Chicago, Ill.

Edward E. Burris, *Chairman, Atlanta*, 2693 Winding La., N. Atlanta 19, Ga. — Charles D. Beeland — L. H. Kelley

Boston
Lester Bernd — Joseph Dephoure — Joseph Rothberg

Donald W. Dixon, *Chairman, Canadian*, Canadian Kodak Sales, Ltd., Mt. Dennis, Toronto
Findlay J. Quinn — Rodger J. Ross

Jack Behrend, *Chairman, Chicago*, TV Equipment Co., 161 E. Grand, Chicago 11

James Anderson, Ray Arn, Jr., S. D. Bateman, Cecil L. Bidlack, James W. Bostwick, Donald Cain, John A. Campbell, Robert A. Colburn, Walter Craig, John W. Ditamore, John Dome, Harold Hanson, William D. Hedden, O. S. Knudsen, Thomas P. Marker, George Meyers, John I. Newell, Reid H. Ray, William Snyder, Arthur Wolf

Lewis Cearly, The Cearly Co., 517 Pennsylvania Ave., Ft. Worth 4
Richard Blair, 1924 Hillburn Dr., Dallas
} *Co-Chairmen, Dallas-Ft. Worth*

William R. McCown, *Chairman, Nashville*, P. O. Box 6215, Nashville, Tenn.
H. R. Briscoe, Jr. — Stanley Hime — J. J. Howell — R. L. Hucaby — W. M. O'Rork — Hal Vinson

Joe T. Dougherty, *Chairman, New York*, E. I. du Pont de Nemours & Co., Inc., 248 W. 18th St., New York
Norman Berger — Vernon Blanchard — Robert Burns — Richard Hyde — William A. Koch — Marshall G. Rothen

Harry J. Lehman, *Chairman, Hollywood*, 3130 Oakshire Dr., Hollywood 28
E. E. Benham, A. C. Curtis, Ted Fogelman, H. E. Gausman, Ray Grant, Ted Grenier, Waldo Hunter, John Lehners, A. C. Macauley, Lou Vincent, Alan M. Gundelfinger

J. S. Chandler, *Chairman, Rochester*, Eastman Kodak Co., Bldg. 59, Kodak Park, Rochester, N. Y.
F. E. Altman, J. L. Forrest, J. D. Hayes, S. C. Holland, Harold Jones, R. C. Lovick, R. E. Putman, J. A. Rodgers, R. D. Shoberg

Harry Jacobs, *Chairman, San Francisco*, 333 Buena Vista Ave., Mill Valley, Calif.
J. L. Berryhill — Alan Campbell — P. M. Davis — Thomas L. Dixon — Peter Onnigian — Jack Shawcroft

Howland Pike, *Chairman, Washington*, R.F.D. 2, Silver Spring, Md.
Charles E. Benton, Jr. — F. W. Garretson — R. N. Jenkins — R. E. Johnson — W. J. Nagel — Philip E. Thomas

D. J. White, *Chairman, Foreign*, Magnasync Mfg. Co., 5546 Satsuma Ave., N. Hollywood

A. Gillet, Pritam Kapila, Marcos Kavlin, W. DeLane Lea, Harry More, Yoshio Osawa, W. M. Sirry, George Tahara, Victor Trentino, Juan Viguie, Santiago Moro Escalona, Yeh Li, H. V. Zeppelin

NOMINATIONS. *To recommend nominations to the Board of Governors for annual election of officers and governors.*

Barton Kreuzer, *Chairman*, Astro-Electronic Products Div., R.C.A., Princeton, N. J.

Carlos H. Elmer, John G. Frayne, George H. Gordon, Gerald G. Graham, Theodore B. Grenier, Leon Shelly, Lloyd Thompson, James L. Wassell

PAPERS. *To solicit papers and provide the program for national conventions, maintain a close liaison with the editorial office of the Society relative to manuscripts for publication, and make available to local sections for their meetings papers presented at national conventions.*

Bernard D. Plakun, *General Chairman*, General Precision Laboratory, Inc., 63 Bedford Rd., Pleasantville, N. Y.

Regional Chairman (United States)

Charles D. Beeland, Jr., *Chairman, Atlanta*, Charles D. Beeland Co., 70 4th St., N. W., Atlanta 8
Harold E. Edgerton, *Chairman, Boston*, 205 School St., Belmont, Mass.
Herbert E. Farmer, *Chairman, Hollywood*, 7826 Dumbarton Ave., Los Angeles
C. L. Graham, *Chairman, Rochester*, 500 Thomas Ave., Rochester 12
Ralph Hucaby, *Chairman, Nashville*, 945 Caldwell La., Nashville
R. A. Isberg, *Chairman, San Francisco*, 2001 Barbara Dr., Palo Alto, Calif.
Roddy K. Keitz, *Chairman, Dallas-Ft. Worth*, Keitz & Herndon, 4409 Belmont, Dallas
Garland C. Misener, *Chairman, Washington*, Capital Film Labs., 1905 Fairview Ave., N. E., Washington, D. C.
Philip E. Smith, *Chairman, Chicago*, Kodak Processing Laboratory, 1212 Prairie Ave., Chicago 16, Ill.
J. Paul Weiss, *Chairman, New York*, E. I. du Pont de Nemours & Co., Inc., Parlin, N. J.

National Regional Chairmen

Western Hemisphere (except United States)

ARGENTINA: Pablo Tabernero, Laboratorios Alex S.A., Dragones 2250, Buenos Aires
BRAZIL: Mario Alderighi, Rua Guarara 60, Sao Paulo
CANADA: Rodger J. Ross, Canadian Broadcasting Corp., 354 Jarvis St., Toronto
COLOMBIA: Pablo E. Carrasco, Kodak Colombiana Ltd., Carrera 13, No. 18–66, Bogota
MEXICO: Robert E. Leslie, Kodak Mexicana Ltd., Administracion De Correos Londres 16, Mexico 6, D. F.
VENEZUELA: Alfredo J. Rosiano, Bolivar Films, C.A., Aptdo. 786, Caracas

Europe

DENMARK: Michael M. Jacobsen, Filmtech Copenhagen, Jensløvs Tvaervej 1A, Copenhagen, Charlottenlund
FRANCE: Jean Vivié, Association Francaise Des Ingénieurs et Techniciens du Cinéma 92 Champs Elysées, Paris 8
GERMANY: Adolf Kochs, Bavaria-Filmkunst AG, Schliessfach 9, Munich
GREAT BRITAIN: Leslie Knopp, The Cinematographers Exhibitors' Association of Great Britain and Ireland, 164 Shaftesbury Ave., London W.C. 2
ITALY: Mario Calzini, Tecnostampa Labs, Via Segesta n. 4E, Rome
THE NETHERLANDS: R. Vermeulen, Philips Research Laboratories, Glocilampenfabrieken, Eindhoven
SWEDEN: Osten Soderlund, Hasselblads Fotografiska, Nybrokajen 5, Stockholm C
SWITZERLAND: Robert H. Suter, Turicop AG, Regensbergstrasse 243, Zurich 11/50

Asia

INDIA: H. Krishnan, Kodak Limited, Kodak House, Hornby Road, Bombay 1
JAPAN: Kiyohiko Shimasaki, Motion Picture Engineering Society of Japan, Inc., Sankei Kaikan Bldg. Rm. 271, No. 3 Otemachi-1 Chiyoda-ku, Tokyo
PHILIPPINES: P. G. Mabanta, Kodak Philippines, Ltd., 102 13th St., Port Area P.O. Box 422, Manila

Australasia

AUSTRALIA: P. H. Budden, Commonwealth Film Labs, 35 Missenden Rd., Camperdown, N.S.W.
NEW ZEALAND: M. J. Ashley, National Film Unit, Darlington Rd., Miramar, Wellington E. 4

PROGRESS. *To prepare an annual report on world progress in the motion-picture and television industries.*

Lloyd Thompson, *Chairman*, The Calvin Co., 1105 Truman Rd., Kansas City, Mo.

Jerzy Adamski	L. J. J. Didiee	K. E. Gondesen	Russell Holslag	Ann Lavorva	Edward H. Reichard
J. E. Aiken	L. G. Dive	Krishna Gopal	Tom Hope	Herbert Meyer	Rodger J. Ross
R. J. T. Brown	Richard F. Dubbe	Robert E. Gottschalk	Eric Horvitch	James C. Morgan	W. C. Rubinstein
Jose Carlos Carbajal	George T. Eaton	Robert A. Haines	Gibas Hubert	Tom C. Nutt	J. Vicinte Scheuren
Piero Cavazzuti	Carlos H. Elmer	M. A. Hankins	Ub Iwerks	B. Olecheycho	E. H. Schreiber
Howard A. Chinn	Robert Fehrmann	John D. Hayes	Walter I. Kisner	Hayward C. Parish	Murray H. Stevenson
Stellan Dahlstedt	M. Fix	Ahmed Hegab	H. N. Kozanowski	J. L. Pettus	J. J. Unger
Robert R. Davis					

PROGRESS MEDAL AWARD. *To recommend to the Board of Governors a candidate who by his inventions, research, or development has contributed in a significant manner to the advancement of motion-picture technology, and is deemed worthy of receiving the Progress Medal Award of the Society.*

Deane R. White, *Chairman*, Photo Products Dept., E. I. du Pont de Nemours & Co., Inc., Parlin, N.J.

George L. Beers, Herman H. Duerr, W. Wallace Lozier, Petro Vlahos

PUBLICATIONS ADVISORY COMMITTEE. *To review the publication policy of the Society in the light of motion-picture and television progress and in respect to the changing interests of the membership with a view to recommending long-range publication policies to the President and the Board of Governors.*

Glenn E. Matthews, *Chairman*, Eastman Kodak Co., Bldg. 59, Kodak Park, Rochester 4

D. Max Beard	Herman H. Duerr	Herbert E. Farmer	Lorin D. Grignon	Pierre Mertz	John W. Servies
Roger J. Beaudry	Raymond B. Dull	John A. Flory	John A. Maurer	Bernard D. Plakun	

PUBLIC RELATIONS ADVISORY COMMITTEE. *To review the public relations activities of the Society and recommend long-range plans to the President.*

James A. Barker, *Chairman*, Capital Film Labs., 1905 Fairview Ave., N. E., Washington, D. C.

Burton F. Perry, James W. Bostwick, Alan M. Gundelfinger, Haig A. Manoogian, Petro Vlahos

RETIREMENT PLAN ADMINISTRATIVE COMMITTEE. *To administer the SMPTE Employees' Retirement Plan.*

John W. Servies, *Chairman*, National Theatre Supply Co., 92 Gold St., New York 38, Marie M. Griffin, Wilton R. Holm

REVISIONS COMMITTEE ON CONSTITUTION, BYLAWS AND ADMINISTRATIVE PRACTICES. *To review and recommend to the Board of Governors revisions to the Constitution, Bylaws and Administrative Practices of the Society.*

Wilton R. Holm, *Chairman*, E. I. du Pont de Nemours & Co., Inc., Parlin, N.J.

Don M. Alexander, Herbert Barnett, Gerald G. Graham, Barton Kreuzer, John W. Servies, S. P. Solow, Ethan M. Stifle, Edwin W. Templin

DAVID SARNOFF AWARD. *To recommend to the Board of Governors a candidate who has done outstanding work in some technical phase of the broad field of television or in any similar phase of theater television, whether in research, development, design, manufacture or operation.*

Frank N. Gillette, *Chairman*, General Precision Laboratory, 63 Bedford Rd., Pleasantville, N. Y.

Max Batsel, Howard A. Chinn, Theodore B. Grenier, Arthur V. Loughren

SUSTAINING MEMBERSHIP. *To solicit new Sustaining members and thereby obtain adequate financial support required by the Society to carry on its technical and engineering activities.*

Byron Roudabush, *Chairman*, Byron Motion Pictures, Inc., 1226 Wisconsin Ave., Washington 7, D.C.

Gerald G. Graham, Everett Miller, Leon Shelly, Harry Teitelbaum, Lloyd Thompson

SAMUEL L. WARNER AWARD. *To recommend to the Board of Governors a candidate who has done the most outstanding work in the field of sound motion-picture engineering, in the development of new and improved methods or apparatus designed for sound motion pictures, including any steps in the process, and who, whether or not a member of the Society of Motion Picture and Television Engineers, is deemed eligible to receive the Samuel L. Warner Memorial Award of the Society.*

John Aalberg, *Chairman*, 4045 Los Feliz Blvd., Los Angeles 27

R. J. Beaudry, Lorin Grignon, Everett Miller, Gordon Sawyer

SMPTE Engineering Committees

The Engineering Vice-President, A. G. Jensen, has appointed the chairmen and committee members listed below to serve for his two-year term of office, January 1, 1958, through December 31, 1959.

Inquiries regarding committee projects or membership should be directed to J. Howard Schumacher, Staff Engineer, at Society Headquarters.

COLOR. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of color motion-picture processes, accessory equipment, studio lighting, selection of studio set colors, color cameras, color motion-picture films, and general color photography.*

A. M. Gundelfinger, *Chairman*, Technicolor Motion Picture Corp., 6311 Romaine St., Hollywood 38

F. J. Bingley, H. E. Bragg, H. P. Brueggemann, A. A. Duryea, R. M. Evans, F. H. Gerhardt, L. T. Goldsmith, R. E. Harrington, W. R. Holm, S. E. Howse, A. J. Miller, W. E. Pohl, C. L. Townsend, L. E. Varden, J. P. Weiss, J. R. Whittaker, W. T. Wintringham

FILM DIMENSIONS. *To make recommendations and prepare specifications on those film dimensions which affect performance and interchangeability, and to investigate new methods of cutting and perforating motion-picture film in addition to the study of its physical properties.*

A. C. Robertson, *Chairman*, Eastman Kodak Co., Kodak Park, Bldg. 35, Rochester 4, N.Y.

J. E. Aiken, W. C. Brandsma, M. G. Brown, A. M. Gundelfinger, W. G. Hill, A. G. Krienke, A. J. Miller, G. C. Misener, W. E. Pohl, M. G. Townsley, W. E. Vary, W. J. Wade

FILM-PROJECTION PRACTICE. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion-picture projection equipment, projection rooms, film-storage facilities, stage arrangement, screen dimensions and placement, and maintenance of loudspeakers to improve the quality of reproduced sound and the quality of the projected picture in the theater.*

Willy Borberg, *Chairman*, General Precision Lab., Inc., 63 Bedford Road, Pleasantville, N.Y.

C. S. Ashcraft, H. E. Behrens, Walter Beyer, F. E. Cahill, P. M. Cowett, L. W. Davee, M. G. Dobbs, R. B. Dull, C. L. Greene, R. H. Heacock, C. F. Horstman, W. H. Ingram, L. E. Jones, J. J. Kohler, F. D. Leslie, H. W. Lotz, Hugh McLachlan, E. E. Moyer, F. H. Riffle, J. F. Rollman, Ben Schlanger, J. W. Servies

INSTRUMENTATION AND HIGH-SPEED PHOTOGRAPHY. *To further the development and utilization of instruments and techniques associated with instrumentation and high-speed photography.*

C. H. Elmer, *Chairman*, Traid Corp. Mail: 410B Forrestal St., China Lake, Calif.

E. C. Barkofsky, H. C. Barr, D. M. Beard, R. M. Betty, M. E. Brown, Alexander Easson, H. E. Edgerton, F. M. Emens, L. L. Endelman, W. C. Griffin, H. T. Harding, W. G. Hyzer, Harold Jones, J. S. Keller, Karl-Heinz Lohse, Kenneth Morgan, J. H. Niemeyer, R. O. Painter, D. H. Peterson, A. E. Quinn, H. R. Roglin, R. D. Shoberg, Morton Sultanoff, J. H. Waddell, R. L. Wolford, C. W. Wyckoff, A. M. Zarem

LABORATORY PRACTICE. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion-picture printers, processing machines, inspection projectors, splicing machines, film-cleaning and treating equipment, rewinding equipment, any type of film-handling accessories, methods, and processes which offer increased efficiency and improvements in the photographic quality of the final print.*

E. H. Reichard, *Chairman*, Consolidated Film Industries, 959 Seward St., Hollywood 38

V. D. Armstrong	O. E. Cantor	T. J. Gaski	C. F. LoBalbo	R. J. Ross	Lloyd Thompson
H. L. Baumbach	G. A. Chambers	F. P. Herrnfeld	E. M. Londre	F. J. Scobey	J. L. Wassell
F. S. Berman	G. W. Colburn	R. P. Ireland	R. H. Nothdurft	V. C. Shaner	J. A. Widmer
T. J. Braun	D. W. Dixon	P. A. Kaufman	W. E. Pohl	J. G. Stott	E. G. Zost
H. P. Brueggemann	John Fritzen	W. F. Kelley			

MOTION-PICTURE STUDIO LIGHTING. *To make recommendations and prepare specifications for the operation, maintenance and servicing of all types of motion-picture studio and outdoor lighting equipment, tungsten and carbon arc light sources, lighting effect devices, lighting filters and auxiliary equipment associated with motion-picture lighting, to increase the general knowledge of the art.*

Petro Vlahos, *Chairman*, Motion Picture Research Council, 6660 Santa Monica Blvd., Hollywood 38

C. W. Barton	R. B. Dull	C. W. Handley	M. A. Hankins	Wallace Kelley	D. W. Prideaux
F. E. Carlson	Karl Freund				

SCREEN BRIGHTNESS. *To make recommendations and prepare specifications for the brightness of the motion-picture screen image, related factors such as ambient light and screen characteristics, methods of measurement in this field, and means for controlling and improving screen brightness.*

R. B. Dull, *Chairman*, National Carbon Co., P.O. Box 191, Fostoria, Ohio

R. E. Birr	L. D. Grignon	L. B. Isaac	Gerhard Lessman	Leonard Satz	Allen Stimson
M. H. Chamberlin	C. W. Handley	W. F. Kelley	Hugh McLachlan	Ben Schlanger	G. H. Walter
P. M. Cowett	A. J. Hatch	F. J. Kolb	O. W. Richards	Edward Stanko	J. J. Zaro
W. E. Gephart	Y. G. Hurd				

16MM AND 8MM MOTION PICTURES. *To make recommendations and prepare specifications for 16mm and 8mm cameras, 16mm sound recorders and sound-recording practices, 16mm and 8mm printers and other film laboratory equipment and practices, 16mm and 8mm projectors, splicing machines, screen dimensions and placement, loudspeaker output and placement, preview or theater arrangement, test films, and the like, which will improve the quality of 16mm and 8mm motion pictures.*

R. E. Birr, *Chairman*, General Electric Co., Lamp Div., Nela Park, Cleveland 12, Ohio

E. W. D'Arcy	A. H. Gorey	R. C. Holslag	D. F. Lyman	W. H. Offenhauser	J. A. Van den Broek
J. L. Forrest	T. B. Gromak	F. J. Kelly	E. J. Mankus	A. C. Robertson	R. T. Van Niman
R. E. French	R. G. Herbst	F. E. Lane	J. A. Maurer	L. T. Sachtleben	W. E. Vary
D. C. Gilkeson	R. H. Hodges	W. W. Lozier	B. F. Melchionni	Lloyd Thompson	W. R. Wilson
Morris Goldberg					

SOUND. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion-picture film, sound recorders, re-recorders and reproducing equipment, methods of recording sound, sound-film processing, and the like, to obtain means of standardizing procedures that will result in the production of better uniform quality sound in the theater.*

L. D. Grignon, *Chairman*, Twentieth Century-Fox Film Corp., Box 900, Beverly Hills, Calif.

E. W. D'Arcy, *Vice-Chairman*, D'Arcy & Associates, Box 1103, Ogden Dunes, Gary, Ind.

F. G. Albin	J. P. Corcoran	B. H. Denney	A. P. Green	A. C. Inman	B. F. Perry
R. J. Beaudry	G. R. Crane	R. J. Engler	J. C. Greenfield	A. H. Lind	J. L. Pettus
H. H. Brauer	I. B. Current	H. E. Fracker	W. K. Grimwood	J. A. Maurer	G. E. Sawyer
F. E. Cahill	Herbert DeGroot	E. W. Franck	R. G. Hufford	J. M. Moriarty	W. W. Wetzel
F. A. Comerci	D. L. Demarest	W. E. Gephart			

STANDARDS. *To survey constantly all engineering phases of motion-picture production, distribution, and exhibition, to make recommendations and prepare specifications that may become proposals for American Standards. This committee should follow carefully the work of all other committees on engineering and may request any committee to investigate and prepare a report on the phase of motion-picture engineering to which it is assigned.*

F. J. Kolb, *Chairman*, Eastman Kodak Co., Kodak Park, Building 35, Rochester 4, N.Y.

Chairmen of Engineering Committees

R. E. Birr	H. A. Chinn	C. H. Elmer	A. M. Gundelfinger	E. H. Reichard	T. G. Veal
Willy Borberg	R. B. Dull	L. D. Grignon	R. M. Morris	A. C. Robertson	Petro Vlahos

Members at Large

H. J. Hood	A. G. Jensen	W. F. Kelley	D. R. White

TELEVISION. *To make recommendations and prepare specifications on all phases of film equipment used in television broadcasting. Further, to make recommendations and prepare specifications on all phases of the production, processing and use of film made for testing of and transmission over a television system.*

T. Gentry Veal, *Chairman*, Eastman Kodak Co., Research Laboratories, Kodak Park, Rochester 4, N. Y.

F. G. Albin	A. A. Chesnes	A. M. Gundelfinger	R. E. Lovell	N. R. Olding	D. W. Shields
E. P. Ancona	J. L. Forrest	S. E. Howse	H. A. Manoogian	J. S. Powers	C. L. Townsend
Herbert Barnett	E. C. Fritts	R. P. Ireland	Pierre Mertz	R. E. Putman	J. R. Whittaker
K. B. Benson	D. C. Gilkeson	H. N. Kozanowski	R. M. Morris	J. H. Roe	W. T. Wintringham
F. J. Bingley	F. N. Gillette	H. R. Lipman			

TELEVISION STUDIO LIGHTING. *To make recommendations and prepare specifications on all phases in lighting employed in television studios.*

R. M. Morris, *Chairman*, American Broadcasting Co., 7 West 66 St., New York 23

H. R. Bell, G. H. Gill, G. T. Howard, H. A. Kliegl, W. R. McCown, C. J. Neenan, Charles Shevlin, R. G. Williams, W. R. Wilson

VIDEO-TAPE RECORDING. *To propose standards and good engineering practices for the construction, adjustment, operation and measurement of video-tape recording and reproducing equipment and for those video-tape dimensions or other characteristics which affect performance and interchangeability.*

H. A. Chinn, *Chairman*, CBS Television, 485 Madison Ave., New York 22, N.Y.

C. E. Anderson, G. W. Bartlett, K. B. Benson, R. J. Bowley, W. K. Grimwood, A. H. Lind, R. M. Morris, G. M. Nixon, R. A. von Behren

SMPTE Representatives to Other Organizations

AMERICAN STANDARDS ASSOCIATION

Board of Directors, A. G. Jensen

Standards Council, H. J. Hood

Photographic Standards Board, A. G. Jensen

Acoustical Standards Board, A. G. Jensen

SECTIONAL COMMITTEES

Motion Pictures, PH22: D. R. White, *Chairman*, Photo Products Dept., E. I. du Pont de Nemours & Co., Parlin, N. J.

J. Howard Schumacher, *Secretary*; H. J. Hood; A. G. Jensen

Sound Recording, Z57, E. W. D'Arcy, L. D. Grignon

Acoustics S1, L. D. Grignon

Photographic Processing, PH4, C. F. LoBalbo

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Members at Large: A. M. Gundelfinger, W. T. Wintringham

INTERNATIONAL STANDARDS ORGANIZATION TECHNICAL COMMITTEE (36) ON CINEMATOGRAPHY

The U.S. National Committee is the personnel of ASA Sectional Committee, PH22

International Advisory Group: A. G. Jensen, F. J. Kolb, J. H. Schumacher, D. R. White

JOINT COMMITTEE ON INTER-SOCIETY COORDINATION (JCIC): A. G. Jensen

This committee was formed some years ago to coordinate the technical activities of mutual interest between the Institute of Radio Engineers National Association of Broadcasters, Electronic Industries Association and the Society of Motion Picture & Television Engineers.

NATIONAL ELECTRONICS CONFERENCE: H. H. Brauer

Annual Awards

A detailed report, including the full text of citations and acceptances, appears in the December 1958 *Journal*, pp. 836–847. A description of the awards and a recapitulation of the recipients of previous years' awards were last published in the April 1958 *Journal*, Part II.

Distribution of Members by Sections—January 1, 1959

Totals—U.S.: 5276; Canada: 249.

Atlanta . . . . . **Total 176**
North Carolina, 12; South Carolina, 11; Mississippi, 3; Alabama, 9; Georgia, 43; Florida, 98

Boston . . . . . **Total 107**
Maine, 5; New Hampshire, 6; Mass., 93; Rhode Island, 3; Vermont, 0

Canada . . . . . **Total 249**

Chicago . . . . . **Total 830**
Colorado, 37; North Dakota, 2; South Dakota, 2; Nebraska, 9; Kansas, 8; Minnesota, 48; Iowa, 18; Missouri, 53; Wisconsin, 33; Illinois, 367; Michigan, 101; Indiana, 48; Ohio, 104

Dallas-Ft. Worth . . . . . **Total 128**
Oklahoma, 12; Arkansas, 3; Louisiana, 15; Texas, 98

Hollywood . . . . . **Total 1647**
Nevada (S.W.), 9; New Mexico, 28; Arizona, 24; So. California, 1586

Nashville . . . . . **Total 42**
Kentucky, 8; Tennessee, 34

New York . . . . . **Total 1614**
Connecticut, 70; Pennsylvania, 101; New Jersey, 319; S.E. New York, 1124

Rochester (N.W. New York) . . . . . **Total 274**

San Francisco . . . . . **Total 219**
Montana, 6; Idaho, 2; Wyoming, 3; Utah, 11; Nevada (except S.W.), 2; Washington, 31; Oregon, 13; N. California, 151

Washington, D.C. . . . . . **Total 239**
Delaware, 9; Maryland, 83; West Virginia, 7; Virginia, 62; D.C., 78

Treasurer's Report—

January 1–December 31, 1958

CASH		
Cash on deposit–January 1, 1958		$111,153
Deposits	$348,514	
Disbursements	345,616	2,898
Cash on deposit–December 31, 1958		$114,051
Petty cash fund		200
Total cash on deposit and on hand		$114,251
INVESTMENTS		
Savings accounts–January 1, 1958	$ 6,892	
Add: Interest credited @ 3½%	243	
Invested @ 3½%	50,000	
Interest credited @ 3½%	932	
Savings accounts–December 31, 1958		$58,067
U.S. Government Bonds (at cost)		30,000
Total Investments		$ 88,067
Total Cash and Investments—December 31, 1958		$202,318

Respectfully submitted, REID H. RAY, Treasurer

Statement of Income and Expenses—January 1–December 31, 1958

INCOME		
Membership dues received		$110,141
Test film operations		
Test film sales	$49,051	
Less: Cost of test films sold	29,488	19,563
Conventions		
Total income–registrations, banquets, etc.	38,771	
Less: Expenses	32,235	6,536
Interest and other income		3,026
Total Income		$139,266
EXPENSES		
Publications		
Cost of publishing Journal, reprints, etc.	$110,383	
Less: Non-member subscriptions, sales to advertisers, etc.	74,381	$ 36,002
Membership records and promotion		9,528
Engineering services		16,703
Administrative		81,426
Sections and Chapters		5,950
Affiliations		1,668
Non-Engineering Committees		1,683
Provision for 1960 5-Year Index		500
Total Expenses		153,460
Excess of Expense Over Income		$(14,194)

Balance Sheet—December 31, 1958

ASSETS		
Cash in bank		$114,051
Petty cash fund		200
Savings accounts		58,067
U. S. Government Bonds (at cost)		30,000
Accounts receivable		11,513
Test film inventory		4,474
Test film equipment (nominal value)		1
Office furniture and equipment (nominal value)		1
Prepaid expenses		2,460
Total Assets		$220,767
LIABILITIES AND RETAINED INCOME		
Accounts payable		5,153
Customers' advance payments		1,156
Membership dues in advance		55,943
Accrued payroll taxes		3,971
Total Liabilities		$ 66,223
Income retained for working capital and contingencies		
Reserve for replacement of test film equipment	$15,070	
Reserve for 1960 5-Year Index	1,500	
Unappropriated–January 1, 1958	$152,168	
Deduct: Excess expense over income—1958	14,194	
Unappropriated–December 31, 1958	137,974	
Total Retained Income		154,544
Total Liabilities and Retained Income		$220,767

Respectfully submitted, JOHN W. SERVIES, Financial Vice-President

Accountants' Report

February 10, 1959

To the Members and Board of Governors of the
Society of Motion Picture and Television Engineers:

In our opinion, the accompanying financial statements present fairly the financial position of the Society of Motion Picture and Television Engineers at December 31, 1958, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year. Our examination of such statements was made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and other auditing procedures as we considered necessary in the circumstances.

SMITH & FLANAGAN
Certified Public Accountants

141 E. 44 St., New York 17

Membership Report—Year Ended December 31, 1958

	Hon.	Fel.	Act.	Assoc.	Stud.	Total Ind.	Sust.	Total
Membership, Jan. 1, 1958	8	258	2074	3[illegible]	409	5770	116	5886
New Members			235	[illegible]	112	834	24	858
Reinstatements			1	18	1	37		37
	8	258	2327	3526	522	6641	140	6781
Resignations		−4	−39	−70	−9	−122	−20	−142
Deceased		−2	−19	−8		−29	−0	−29
Unpaid Members Removed 12/31/58		−3	−147	−312	−109	−571	−8	−579
	8	249	2122	3136	404	5919	112	6031
Transfers:								
Student to Associate				+30	−30			
Associate to Active			+241	−241				
Active to Fellow		+15	−15					
Active to Associate			−10	+10				
Associate to Student				−2	+2			
Fellow to Honorary	+1	−1						
Membership, Dec. 31, 1958	9	263	2338	2933	376	5919	112	6031

Nonmember Subscriptions: December 31, 1958 — 1657.

news and reports

Positive Thinking in the Motion-Picture Exhibit Industry

THE DEATH-KNELL of the motion-picture industry has not yet rung, but a few premature taps on the bell were sounded by movie-celebrities Orson Welles and Ben Hecht in articles published in the March issue of *Esquire*. The Welles article "Twilight in the Smog" and the Hecht effort, "Elegy for Wonderland," are both somewhat more than clever claptrap but considerably less than a definitive analysis of Hollywood's problems. The articles (part of a "report" called "A Hard Look at the New Hollywood") represent the negative thinking that is all too prevalent in this area.

For the readers of this *Journal*, the *Esquire* articles are hardly required reading; but for Society members in many areas of motion pictures who do not read the exhibitor trade papers a review of efforts in recent months by exhibitor organizations is in order.

SMPTE members are aware of the Society activities of developing standards (and test films for the industry), devising procedures and reporting on needs (Screen Brightness Committee surveys, reports and symposiums), publishing articles in the *Journal* and special items such as the Wide Screen booklet. The Society's Education Committee has provided the industry with numerous courses in recent years to bring current technologies to sound and other technicians.

Fortunately, the challenge of negativism has been taken up by many segments of the industry and many signs point to the revival of a healthy and realistic approach in facing today's problems. One of the most important moves in a positive direction has been taken by the men who, early in November met to form a united front for the benefit of the industry and laid the groundwork for the American Congress of Exhibitors (ACE). Another example of a positive and realistic approach is that of the Motion Picture Industry Council of Canada (MPICC) which, last Fall, passed a resolution in support of stereophonic sound. The Theatre Owners of America (TOA) has an extensive plan and a study of needs under way. This Society has volunteered its assistance to the TOA and is now in the process of exploring possibilities of specific projects.

Last-Ditch Stand?

ACE has been in existence almost five months and already its influence has been marked in many areas including that of legislation. In addition to flurries of legislative activity in Washington, D.C., on the toll-TV front, upon which the attitude of ACE may have some bearing, the Executive Committee of ACE and its six standing committees have appointed subcommittees to seek clarification from the Department of Justice of the status of block booking, production and distribution by former affiliated circuits, and pooling arrangements.

Launched November 14 at a meeting of exhibitors called by Spyros P. Skouras, 20th Century-Fox President, ACE was established as a permanent organization at the following meeting, held in mid-December. At the November meeting a statement was formulated setting forth the purposes of the group:

"The purpose of the organization is to establish a single organization that will act for exhibition in a manner parallel to the way the Motion Picture Association of America, headed by Eric A. Johnston, speaks for production and distribution. Forming the American Congress of Exhibitors affords the opportunity to America's exhibitors — all of them — to cure some of the industry's ills and to achieve the highest level of motion-picture entertainment in the industry's history. Every exhibitor automatically is a member of ACE. Theater operators will be called upon to serve on subcommittees which will be formed to probe more deeply into each point of the agenda now in preparation. Each member has the right to speak and therefore the opportunity and obligation to work."

Whatever else has been or will be accomplished by ACE it has certainly dramatized an abrupt abandonment of any head-in-sand policy in favor of the head-on (or nettle-grasping) approach to the problems resulting from changing patterns of behavior on the part of movie-goers.

Crisis Situation

Recognition of a crisis situation in the motion-picture industry was the dominant theme of the organizational meeting of ACE. Prior to the meeting, Mr. Skouras stated, "This is the time which will decide whether our industry lives and prospers or withers and dies."

The situation which brought about the organization of ACE did not occur overnight and is not limited to any one area, nor is it exclusively the problem of the industry within the United States. The introduction to the Society's Progress Report for 1956 (p. 241 of the *Journal* for May 1957) contains an admirably clear and explicit statement concerning the state of the industry and the possible causes of a disappointing lack of progress in the motion-picture field:

"Every few years something like magnetic recording or wide-screen photography comes along and there are several years of accelerated activity in the motion-picture field; 1956 was not such a year. Wide-screen, stereophonic sound, and magnetic recording had all become routine. Several committee members reported that they were unable to find anything new worth reporting in their field and some said that in the theater field research and capital improvement funds had been cut back: two newsreel companies stopped operation; it was expected that 6000 movie houses would close; for the first time all companies used joint film depots; deals were initiated for studio mergers; but Hollywood was busier than ever, and much of this was the result of television and other activity."

The trend so ably described in the 1956 Progress Report is gaining momentum, and the tide-stemming ability of ACE has yet to be proved. Six main areas of interest have been agreed upon: Post-1948 features on television; relations between producer-distributors and exhibitors; industry-government relations; ways and means to increase motion-picture productions; industry research; and toll television.

One of the main goals of ACE has been the achievement of complete unity among exhibitors and agreement as to aims and methods of accomplishing those aims. Following the initial meeting, an ecstatic editorial in *The Independent Film Journal* (Nov. 22, 1958) described the "inspired meeting" at which: "There was no bickering. There was no name calling. There were no personality conflicts. The bitterness and mistakes of the past were laid to rest. There was no attempt to dictate policies by any one group. At long last there was a realization that all of exhibition was in the same boat. . . ."

Since that editorial was published, this ideal situation seems to be curling around the edges — just a trifle. One of the main problems facing ACE, and one which was, of course,

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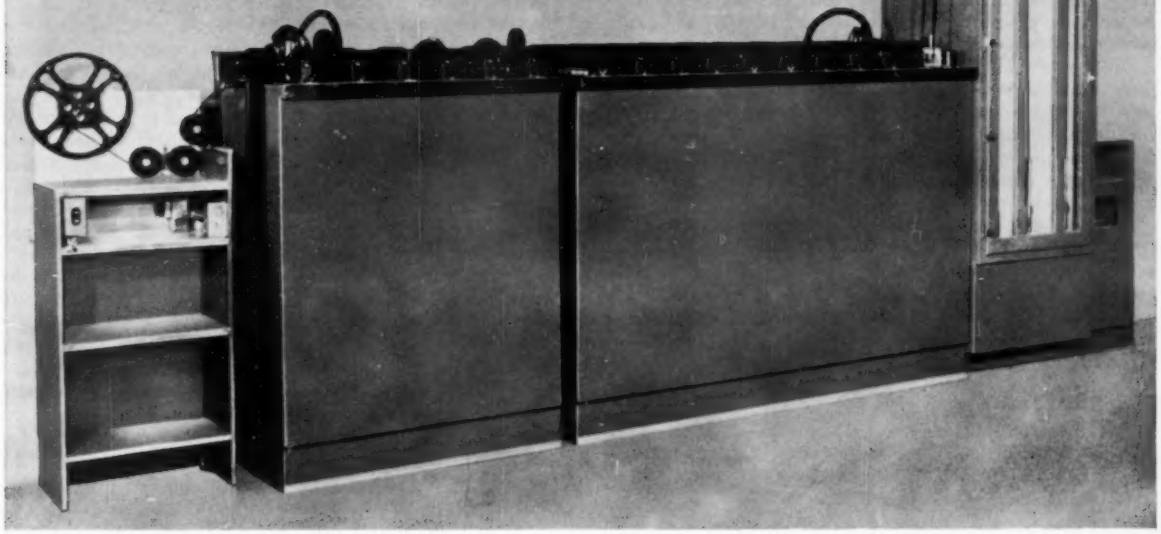

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immediately recognized, is that of possible overlapping or conflict of inter- and intra-organization interests. This problem is one which, apparently, members of ACE and other organizations are making a serious and dedicated effort to solve.

Among the early paeans of praise, the powerful *Hollywood Reporter* (Dec. 9, 1958) sounded a slightly discordant note. "If the 26-member committee of ACE really takes hold of things," the *Reporter* stated, "the industry as a whole will benefit. However, we suggest that each member of the committee confer at great length with the men and women actually running their theaters. . . ."

Divested of the superlatives, it would appear that the formation of ACE represents a sincere attempt by able, responsible men to make a rational approach to a grave problem. Its effectiveness depends on the ability of representatives of the diverse groups within the organization to achieve a unified point of view and also, in some degree, on making the "grass-roots" approach suggested by the *Hollywood Reporter*.

It could also be suggested that along with combatting "evils," such as toll TV, a positive and constructive course of action might be encouraged. The concept of the "positive approach" was suggested by the 1956 Progress Report which related "accelerated activity" in the motion-picture field to new developments, to inventions, new ideas and to better adaptation and application of long-accepted ideas and developments.

The MPICC Approach

The "positive approach" to problems affecting the entire industry may be exemplified by action taken by the Motion Picture Industry Council of Canada. The Resolution approved at the Fall meeting states in part:

"Whereas stereophonic high fidelity is an outstanding improvement over any monaural sound (and) is even more suitable to motion pictures than for home listening, although less obvious; whereas the motion-picture industry pioneered the public use of stereophonic sound and greatly furthered high fidelity, it, therefor, seems a great pity that, having done all this, we are now letting others capitalize on our own efforts. . . . therefor be it resolved that the Motion Picture Industry Council of Canada recommends and strongly urges all theaters that can possibly do so to install modern sound equipment. . . .and further recommends and strongly urges all producers and distributors to make available pictures recorded in a modern manner — by modern, the Council means stereophonic magnetic recording and playback."

The MPICC approach represents what is perhaps the most positive of all positive thinking, the ability to recognize new trends and new areas of public interest and to take full advantage of them. Stereophonic sound was added to the ACE agenda for topics to be discussed with heads of production and distribution. The action was taken during the February meeting.

It may be of interest that an objection has been raised to the term "stereo sound." Max Cohen, Chairman of the ACE Committee on Industry Research, said that the committee hopes to substitute a new and more suitable word for the "grossly misused" and "obscure" term, "stereo sound." The new word would refer exclusively to stereophonic sound in the theater.

It is obvious that there will be no quick or easy solution to the problems of the industry, but the enthusiastic welcome greeting the advent given the efforts cited above indicates that the "dying" industry is at present a lively invalid, and that the future may hold some surprises.—*R.H.*

Academy Awards

A 10-kw lamp and an anamorphic lens earned Class II Academy Awards this year in the Scientific and Technical category and Class III Awards were presented for the development of a high-speed intermittent movement for a 35mm motion-picture theater projection equipment and for a rapid fire semiautomatic compressed air gun, called a marble gun, which is used to simulate bullet effects on a water surface.

Plaques honoring Don W. Prideaux, Roy Leighton, and the Lamp Division of General Electric Co. were presented for the development and production of an improved 10-kw lamp for motion-picture set lighting. The Award-winning lamp is the subject of a *Journal* paper, "Design Improvements in High-Wattage Tungsten Filament Lamps for Motion-Picture and Television Studios" by Leroy G. Leighton and Alfred Makulec (*Journal* pp. 530–533, Aug. 1958). The citation states that the lamp "has doubled the life of its predecessor and maintains higher light output throughout its life. It is stronger mechanically, reducing losses in transport and handling."

Panavision Inc. received an Award for the design and development of the Auto Panatar anamorphic photographic lens. The citation states, "The novel design of these lens substantially reduces photographic lateral distortion and thereby improves close-up quality and overall definition." The Award was accepted by Robert E. Gottschalk on behalf of his firm.

A Certificate signifying Honorable Mention for a Class III Award was presented to Willy Borberg of General Precision Laboratory for the development of the high-speed projector intermittent movement which, because of a larger shutter opening permits a greater amount of light to pass through the film, thereby increasing screen brightness. "It allows better light distribution on the screen with lower flicker perception, and is a definite contribution to improved projection quality," the citation states.

The Award-winning device represents years of intensive study by Mr. Borberg. Earlier research has been reported in the *Journal:* "Modulated Air Blast for Reducing Film Buckle," pp. 94–100, Aug. 1952; also, "Effect of Gate and Shutter Characteristics on Screen Image Quality," pp. 623–626, Oct. 1957.

Fred Ponedel, George Brown and Conrad Boye of Warner Bros. were presented Class III Certificates for design of a rapid fire marble gun that simulates the effects of bullets striking water.

The Awards were presented during the Academy Award Presentation Ceremonies April 6.

Correction: The Advance Program for the 85th Convention published in the March *Journal* indicated on p. 170 that a Post-Convention Tour on Saturday, May 9, would include Cape Canaveral. This was in error in that the tour is limited to the Technical Laboratory at Patrick Air Force Base.

Education, Industry News

A color film on the subject of infrared spectroscopy was exhibited at the annual Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy held during the first week in March. The film, sponsored by Perkin-Elmer Corp., Norwalk, Conn., and produced by Rensselaer Polytechnic Institute, Troy, N.Y., delineates the theory of infrared spectroscopy and shows how it is used in research.

The London Financial Times has announced the appointment of an Industrial Film Correspondent to conduct a regular column on industrial and documentary motion pictures. The announcement stated that this is the first such column to be published by any daily newspaper in Great Britain. The paper has also organized a study group for participation in the In-

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Benzyl Alcohol	PH4.181–1954
Borax, Photo Granular	PH4.230–1954
Boric Acid, Photo Granular	Z38.8.103–1949
Citric Acid, U. S. P. Granular	Z38.8.102–1949
Formaldehyde, N. F. Solution 37%	Z38.8.152–1949
Graphol (Metol)	PH4.125–1956
Hydroquinone	PH4.126–1955
Potassium Alum, U. S. P. Granular	Z38.8.150–1949
Potassium Bichromate, Photo Granular	PH4.300–1958
Potassium Bromide, U. S. P. Granular	PH4.200–1955
Potassium Ferricyanide, Fine Granular	PH4.302–1958
Potassium Metabisulfite, Granular	PH4.277–1957
Potassium Persulfate	Z38.8.181–1949
Sodium Acetate, Anhydrous Granular	PH4.176–1958
Sodium Bisulfite, Photo Powdered	Z38.8.276–1949
Sodium Bromide, U. S. P. Granular	PH4.207–1954
Sodium Carbonate, Monohydrate	PH4.227–1954
Sodium Hydroxide, N. F. Pellets	PH4.225–1956
Sodium Metaborate, Octahydrate	PH4.231–1954
Sodium Sulfate, Anhydrous	Z38.8.175–1949
Sodium Sulfite, Anhydrous Photo	PH4.275–1952
Sodium Thiocyanate, N. F. Crystals	PH4.177–1956
Sodium Thiosulphate, Rice Crystals	PH4.251–1953

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dustrial Photographic and Television Exhibition held in London, April 20–24.

Management Evaluation of Domestic Film Festivals and Awards is a 6-page report by the Audio-Visual Committee of the Assn. of National Advertisers Inc., 155 E. 44 St. New York 17. Published as an aid to management in the evaluation of film festivals and awards in terms of the best interests of sponsor and producer, the committee recommends that special attention be given film categories with emphasis on proper grouping according to subject, objectives, and audience and production limitations; that a procedure be established to select judges with special knowledge and qualifications appropriate to the category under consideration; that more detailed information be required of those submitting films to make possible a wider basis for preliminary evaluation; and that publicity be handled for maximum benefits for sponsors and producers.

The Dew Line Story is a film showing in vivid detail the tremendous story of the construction of Dew Line — the 3000-mile system of radar stations stretching from Northwest Alaska to Baffin Island in eastern Canada, built cooperatively by the United States and Canada. Produced by Audio Productions Inc., 630 Ninth Ave., New York 36, the motion-picture crew who filmed each step of the three-year operation worked side-by-side with the construction crews in sub-zero temperature with the added problem of protecting cameras and sensitive equipment.

Western Electric Co., the manufacturing unit of Bell Telephone System, under an Air Force contract was in charge of the supervision and construction. In the initial stages of the operation, equipments, including small tractors, were dropped by parachute. Strips were then constructed for aircraft, some planes making unprecedented ice landings to bring in heavy machines. An hour-long pictorial report, eventually televised over a 35-city network, was made for the Air Force. A 27½-min version is distributed by Bell Telephone System through its 21 local associated companies and by Western Electric.

The British IRE Convention will be held in the Univ. of Cambridge, July 1–5. Delegates will be housed in the colleges of the university. The 4th Clerk Maxwell Memorial Lecture will be delivered during the Convention by Vladimir K. Zworykin, the distinguished physicist who was awarded the Nobel prize for his work on transistors. Dr. Zworykin is a member of the Society. Among other distinguished participants will be S. K. Mitra, Emeritus Professor of Physics, Calcutta University. Dr. Mitra is internationally known as an authority on the ionosphere.

The National Audio-Visual Convention and Exhibit will be held July 26–29 at the Morrison Hotel in Chicago. Concurrent sessions will include: *Meetings:* National Audio-Visual Assn.; Educational Film Library Assn.; *Conferences:* Heads of Audio-Visual Departments in the medical field; Heads of Audio-Visual Departments in large industries; *Workshops:* Agriculture; Religious; Industrial Training Directors. Further information is available from Henry C. Ruark, Director of Information, National Audio-Visual Assn., Fairfax, Va.

The Annual Convention of the Society of Photographic Instrumentation Engineers will be held at the Ambassador Hotel, Los Angeles, Aug. 4–6. Twenty-three technical sessions are scheduled on the general theme of *Requirements of Space Age Technology*. Precision instruments used in the acquisition and analysis of photographic data will be displayed in an Exhiborama of Equipment. Further information is available from A. J. Carr, Executive Secretary, Box 288, Redondo Beach, Calif.

Undergraduate enrollment in engineering courses is declining but graduate study continues on the upgrade, according to a report on a survey conducted by the American Society for Engineering Education, Univ. of Illinois, Urbana, in cooperation with the U.S. Office of Education. Results of the survey show that 153 accredited engineering colleges had 2.9% less students in the Fall of 1958 than in the Fall of 1957 with 11.6% fewer freshmen matriculating in engineering than in 1957. The report, which gives statistics by class level for each institution, was published in the February 15 Yearbook issue of the *Journal of Engineering Education*. It has also been published as Circular No. 555 of the U.S. Office of Education.

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Zeiss Moviscop Viewer	$94.00
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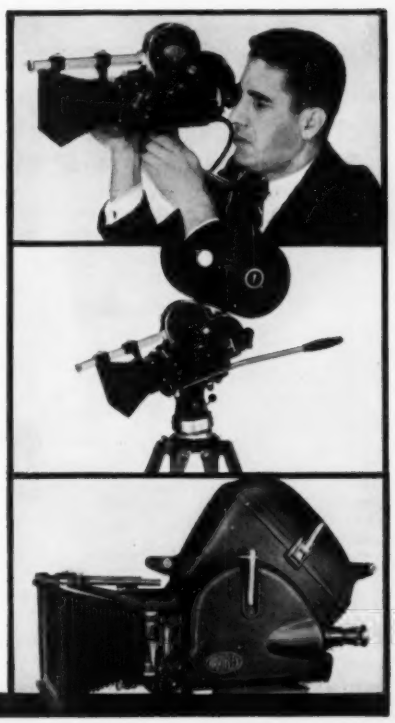

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Guide to the National Defense Education Act of 1958, Circular No. 553 of the U.S. Department of Health, Education and Welfare, explains in nonlegalistic language the provisions of Public Law 85-864 and the steps taken to implement the Act. Title VII which provides for research and experimentation in more effective utilization of television, radio, motion pictures and related media for educational purposes has authorized $3 million for the fiscal year 1958–59 with an initial appropriation of $500,000 alloted by the Office of Education. The Act also authorizes $5 million for each of the three succeeding years to support research in this area. A National Advisory Committee appointed by U.S. Commissioner of Education Lawrence G. Derthick reviews applications for grants under the Act. Instructions for preparation of applications together with an explanation of the Committee's criteria for evaluating proposals (Budget Bureau No. 51-R281) has been prepared by the Office of Education and is available from the National Assn. of Educational Broadcasters. Circular No. 553 is available from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., at 30 cents.

The Godlove Award of the Inter-Society Color Council has been presented to Ralph M. Evans, Director, Color Technology Div., Eastman Kodak Co., for outstanding contributions to the knowledge of color and color photography. He is Secretary of the Council and a Past-President. Presentation of the Award was made by President Walter C. Granville during the 28th Annual Meeting of the Inter-Society Color Council held April 1 in New York.

Cleveland C. Soper, head of Eastman Kodak Tropical Research Laboratory in Panama City has been given a two-year honorary appointment as Research Associate to the Smithsonian Institute in the Panama Canal Zone Biological Area. Previously, Mr. Soper had been given an honorary appointment as consultant to authorities on Barro Colorado, an island in Gatun Lake located midway in the Panama Canal, where Kodak's tropical research staff has maintained a station for several years. During World War II, Mr. Soper served in the Army Air Corps as photographic officer in the Southwest Pacific. He was responsible for units working on camera repair, corrosion control and other problems of tropical photography.

W. Lyle Brewer has been appointed Director of the newly formed Management Systems Development Dept., Kodak Park Works, Eastman Kodak Co. The new department, part of Kodak Park Comptroller Div., will be responsible for design, installation and coordination of business systems. Prior to his present appointment, Dr. Brewer served as general supervisor of technical services in the color print and processing organization at Kodak Park. A member of this Society, he is co-author (with Murray C. Goddard and Stanley A. Power) of a paper on "Evaluation and Control of Direct-Reading Color Densitometers" (*Jour.* pp. 561–565, Oct. 1955) and (with Ralph M. Evans) on "Observer Adaptation Requirements in Color Photography and Color Television" (*Jour.* pp. 5–9, July 1954).

Edward G. Stamboulian has been appointed Marketing Manager, Professional Products, Motion Picture Division for Ansco. He has been with the Ansco organization 32 years and for 12 years prior to his present appointment he has been Assistant Manager of Motion Picture Sales. In his new position he will be responsible for the planning and marketing of all motion picture products.

Charles W. Seager has been appointed Manager of Federal and Contract sales for Ansco. He has been with Ansco for 13 years, holding positions in Technical Service and Sales. For the past three years he has been Manager of Professional Motion Picture Sales. In his new position he will be responsible for the administration and supervision of Federal and contract sales activities.

J. L. Quigley, Assistant Superintendent, Apparatus and Optical Div., Eastman Kodak Co., Rochester, N.Y., has been appointed Chairman of the Committee on Photographic Apparatus, American Standards Assn. He has been with Eastman Kodak since 1938 and has been a representative to ASA since 1955.

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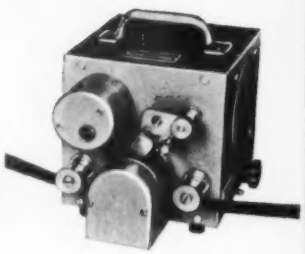

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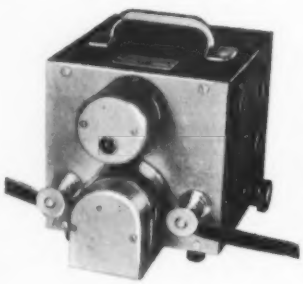

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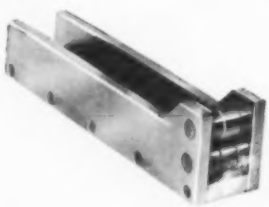

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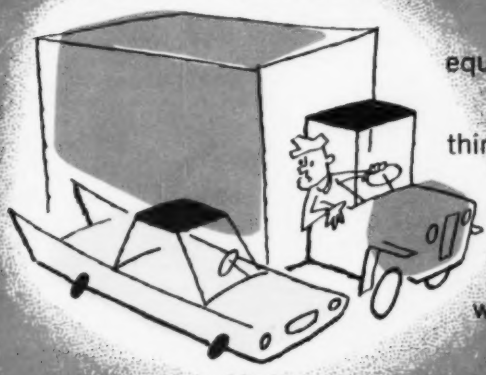

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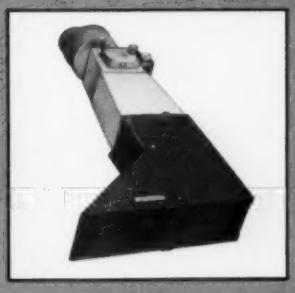

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Mirror reflex camera with direct, through-the-lens focusing and viewing, and three-lens turret. Features stronger hand grip motor to pull new 400' color magazine. Portable, rugged, dependable. The world's standard among cameramen.

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Films for Education Inc., Audio Lane, New Haven 11, Conn., is a new organization for the production and distribution of audio-visual materials for schools and colleges. Officers are Mackey Barron and Donald C. Hawthorne. Edwin O. Dix, formerly on the staff of Jam Handy Organization Inc. of Detroit, is Director of Sales.

Ronald S. Scott

The retirement of Ronald S. Scott has been announced by Eastman Kodak Co., Rochester, N.Y. At the time of his retirement he held the post of Technical Assistant to the Manager of Color Print and Processing, Kodak Park Works, to which he had been appointed in 1953. His career with Eastman Kodak began in 1923 when he joined Kodak Research Laboratories as a chemical engineer in the Techno-Chemical Div. Later that year he transferred to the Photographic Dept., and in 1926 he transferred again to the then new Cine-Kodak Processing Dept. He was appointed Superintendent of the department in 1937, a post he held until his appointment to the post from which he retired. A member of the Society, Mr. Scott is also a member of the honorary chemical fraternity, Phi Lambda Upsilon, the American Chemical Society, and the Rochester units of the Photographic Society of America and the Optical Society of America.

Maurice Parisier, President of Maurice I. Parisier & Co., 741-745 Washington St., New York 14, has been awarded the Cross of the Chevalier de la Légion d'Honneur "in recognition of his services to the development of French technique in the United States." During his 30-year career in the field of electronics, M. Parisier has been a member of a number of important French technical missions and has acted as consultant to U.S. government agencies.

A graduate engineer of the Institut d'Electricité de Grenoble and of the Ecole Supérieure d'Electricité de Paris (1927), he was granted a French patent in 1932 for the invention of a gas discharge tube for the registration of variable currents on a photosensitive film. Since that time he has been granted a number of United States and other patents for electronic devices and developments, many in the field of telecommunications and telemeasurements. He came to the United States in 1943 as engineer and consultant to French missions in the United States. He has been a member of the Society since 1950.

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section reports

Twenty Section Reports were tabulated in the March *Journal*. This regretted departure from the custom of publishing a full report of each Section Meeting soon after it is received has become necessary because of an increasing time-lag, in some instances of several months, caused by lack of space in the *Journal*. The reports tabulated below have been awaiting space for publication for several months. In order to publish at least a minimal report of each Section Meeting, this abridgment has been decided upon.

Section, Date, Place, and Reporter	*Program*
Dallas-Fort Worth, Sept. 19, Engineering Auditorium, Arlington State College—*E. J. Pattist*, Secretary-Treasurer, 3618 Marsh Lane Pl., Dallas	"Polaroid Transparency System" by *Harry Goldstein*, Tucson High School "Fairchild Mini-Rapid 16 Processor" by *Gerard Morio*, Fairchild Camera and Instrument Co. "Westrex Stereo-Disc" by *Don Havens*, Westrex Corp. "Some Aspects of Video Taping a Live Television Show" by *E. E. Benham*, Chief Engineer, Station KTTV
Hollywood, Oct. 21, Station KTTV—*Robert G. Hufford*, Secretary-Treasurer, c/o Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38	
New York, Sept. 12, U.S. Naval Training Device Center, Sands Point, L.I., N.Y.—*Robert M. Fraser*, Secretary-Treasurer, c/o Itek Corp., 700 Commonwealth Ave., Boston 15	Tour of Training Device Center conducted by *Capt. E. C. Callahan* and *Col. K. H. Hunter*.
———, Oct. 1, World Affairs Auditorium, Carnegie Endowment Center	"Possibilities for Improvements in Photographic Sound Recording" *by John A. Maurer*, JM Developments, Inc. "The Effect of Developing Time Upon Distortion in Variable-Area Recording" by *George Lewin*, Army Pictorial Center, L.I.C.
San Francisco, Aug. 12, Marvin Becker Film Studios—*Rodger L. Woodruff*, Secretary-Treasurer, c/o KRON TV, 929 Mission St., San Francisco	"Some Aspects of Chemistry in Color Photography" by *Norwood L. Simmons*, Eastman Kodak Co., Hollywood 38 "Magnetic Striping Techniques" by *Marvin E. Becker*, Marvin Becker Film Studios, San Francisco
———, Sept. 9, INSUL-8 Corp., San Carlos, Calif.	"Some Experiments in Stereo Photography" by *T. L. Ford*, INSUL-8 Corp., San Carlos "VICON Closed Circuit TV Equipment" by *Bruce Scrievers*, INSUL-8 Corp., San Carlos
———, Oct. 21, KGO-TV Studios	"Straight Line vs Toe Recording for Kinescopes or Is Photographic Video Recording Still in the Running?" by *William A. Palmer*, Palmer Films, Inc., Menlo Park
Washington, July 23, NBC Studio, WRC-TV—*Henry M. Fisher*, Secretary-Treasurer, 4003 Underwood St., Chevy Chase 15, Md.	"An Improved Professional 16mm Reversal Color Camera Film" by *H. Edward White*, Eastman Kodak Co. "Operation Deepfreeze" by *Richard R. Conger*, USN, Assistant Photo Officer for Commander, Naval Support Forces, Antarctica
———, Nov. 13, National Academy of Sciences	"Photography and the Geophysical Year" by *William F. Swann*, Eastman Kodak Co., Rochester "Production Planning of Filmed Missile Progress Reports" by *William F. Romeike*, Glenn L. Martin Co., Baltimore "New Stereophonic Speaker System and Its Application to 16mm" by *Col. Richard H. Ranger*, Rangertone, Inc. Newark, N.J.

The Boston Section held its first official meeting on March 24th at the WBZ-TV studios in Boston. Harold Bresson of the Ampex Corp. and Joe Dougherty of the Du Pont Photo Products Dept., addressed the meeting on the subject of "Motion-Picture Film and Video Tape in Television." Both speakers traced the growth of their recording media and indicated to which specific applications each was best suited.

Mr. Bresson pointed out that the acceptance of the Ampex VTR system has been so wide that the company is now manufacturing 40 units per month for television stations, commercial production houses, and special applications. Recent advances in machine design and utilization have led to compatibility of recordings from one machine to another, easier and more successful tape splicing, and longer tape and head life. Some problems yet to be overcome are a practical tape duplication method (since duplication is now done at normal record-playback speed), and quality deterioration in dubbing after two generations.

Mr. Dougherty stressed the advantages of film over video tape for most uses because of its low cost-high quality mass distribution methods and universal acceptance. There is an overall production safety and practicality through the use of film technicians and specialists who are using techniques that have been improving for over fifty years. He cited the advantages of editing a "visible" scene to a given frame, after careful study, to set a mood, rather than making a split-second irrevocable decision as might be the case in a live show which is taped.

A lively discussion followed the formal presentations at a coffee break sponsored by the Eastman Kodak Co. Conclusions drawn from the talks were that while VTR surpasses film as a means of recording a live television presentation for limited quantity distribution or network use in delayed broadcast, it cannot now and is not intended to replace all film in television programming.

Following the discussions by Mr. Bresson and Mr. Dougherty the following slate of officers was elected unanimously for the balance of 1959: Edward H. Rideout, Avco Crosley, *Chairman*; Robert M. Fraser, ITEK Corp., *Secretary-Treasurer*; *Board of Managers*: Joe Rothberg, Dekko Films (membership chairman); Lester Bernd, Cine Video Labs (Program Chairman); Bruce Harding, Harvard Business School; Louis Lindauer, Trans Radio Productions; David Waddell, Altec Corp.; and Ernest Kessner, Eastern States Farmers' Exchange. —*Louis F. Lindauer*, Acting Secretary, c/o Trans Radio Productions, 683 Boyleston St., Boston. COpley 7-5760.

The Canadian Section met on March 12th at Caldwell Queensway Studios in Toronto. Seventy members and guests attended the meeting, which included a panel discussion on functional photography with emphasis on motion-picture applications.

Don Dixon, Canadian Kodak, opened the meeting with a screening of the Kodak film, "Functional Photography." Following the screening, five prominent panelists addressed the meeting.

Dr. Irving Glass, of the Institute of Aerophysics, University of Toronto, discussed various methods of photographing airflow over models in wind tunnels, with illustrations of the different techniques.

Bill Jones, PYE Canada Ltd., described how closed-circuit television has been used functionally. Among the uses outlined were underwater salvage, X-ray, ultra-violet and infrared inspectors. A TV camera for inspection of nuclear reactors and other radioactive devices was discussed.

Squadron Leader S. F. Davies, of the Central Experimental and Proving Establishment of the Royal Canadian Air Force, outlined the uses of conventional and high-speed motion pictures in the testing of service aircraft, their components, armaments and other features such as the end-of-runway stopping barriers.

R. C. Jacobson, physicist in the structural research department of the Hydro Electric Power Commission of Ontario, described the development and use of two special motion-picture cameras adapted for unique uses. One was a bore-hole camera which

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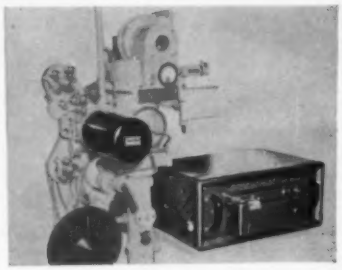

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when dropped down vertical holes in the earth etc., under such things as dams, could give a continuous record of all sides of the hole from top to bottom.

The other unit described by Mr. Jacobson was a war surplus GSAP camera adapted for examining horizontal cable-carrying ducts. The ingenuity of the development and use of these cameras dramatically illustrated the uses to which functional photography has been put.—R. Ringler, *Secretary-Treasurer*, 85 Eglinton Ave., E., Toronto, Ont., Canada.

The Hollywood Section meeting of March 17th had an attendance of 260 to hear discussions of broadcasting of stereophonic sound using AM, FM and TV. Robert Trachinger, Manager of Engineering Operations at ABC-TV, was host to the meeting which was held at the ABC Television Center in Hollywood.

Five speakers addressed the group. They were George Otte, Audio Maintenance Supervisor, ABC-TV, who talked about "Audio Facilities for the Lawrence Welk Show in Stereo;" Don McCroskey, Transmission Engineer, ABC-TV, "Transmission Problems in Network Stereo Broadcasting;" John Allen, Supervisor, Video Recording, ABC-TV, "Recording and Playback of Stereo Sound with Ampex Videotape Machines;" Roger Carroll, KABC Radio, "AM-FM Stereo Broadcast Using Special Recordings" and Robert Cook, Walt Disney Prods., "The Walt Disney Presents Program Titled 'The Peter Tchaikowsky Story' in 3-Channel Stereo."

Stereo sound as used on the Lawrence Welk Show was interestingly described by the technical personnel of ABC. The presentation was carried out in a manner similar to a TV broadcast and moved along at a regular production tempo. The use of a TV camera and closed-circuit monitors made it possible for all the 260 members and guests in the audience to be brought into the audio control booth, in effect, which normally two or three men would crowd.

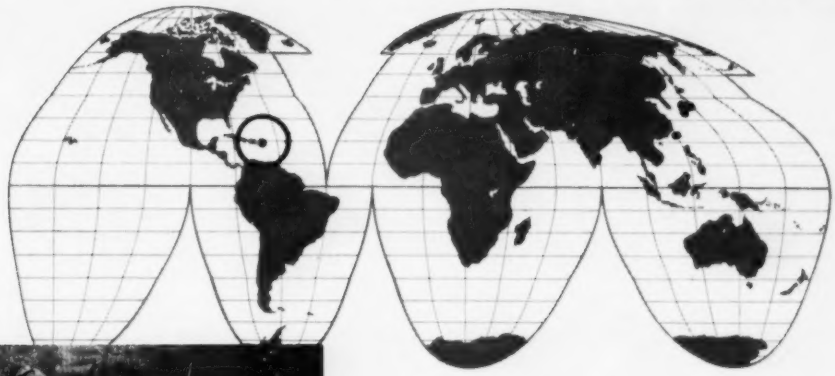
Members were able to see close up the complex array of controls on a stereo mixer panel. The placement of the many microphones for their respective channels was cleverly shown by red lights mounted on mikes on Channel A and green lights on Channel B. The speaker indicated positioning by switching on respective lights.

The demonstration was on the Lawrence Welk stage and the orchestra arrangement of music stands was directly in view. The monitors were again used to display closed-system tape recordings of how the two sound channels were recorded on two Videotape Recorders with Channel A sound on one and Channel B on the other. The synchronization of the two signals was shown on a dual presentation scope and the mechanics of control were illustrated. Then, five minutes of the recorded Welks program was presented.

Mr. Carroll, who has a regularly scheduled stereo music show on KABC AM-FM, presented, by magnetic recordings, sections of typical stereo programs.

Mr. Cook, Sound Director of Walt Disney Productions, explained the tech-

AROUND THE WORLD WITH MAGNASYNC

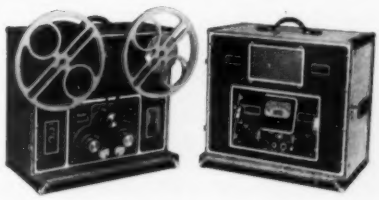


san juan (Puerto Rico)

Viguie Film Productions, Inc. with main studios in San Juan, Puerto Rico, frequently assigns its camera and sound crews to the deep, rugged areas of the country where mountains, rivers and streams provide excellent settings.

Photos at left show Viguie sound engineers using Magnasync equipment to record an interview with a native woman as she does her laundering in a mountain stream. Viguie engineers have found in Magnasync equipment the portability and reliability so essential to quality recording under the severe environmental conditions of this tropical Caribbean island... extreme heat and humidity.

In addition to portable equipments, such as the 16 mm "Type 5", Viguie also has a complete studio installation of 602 Series Magnasync recorders and dubbers. Other Magnaphonic Sound System installations in Puerto Rico are:



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nique of 3-channel sound as used in the Disney TV presentation of "The Sleeping Beauty." Two magnetic sound channels and one optical are used on 35mm black-and-white film. A sequence from the film was presented on the monitors, and the sound was heard from three speakers symmetrically placed on the stage.—Carl W. Hauge, *Secretary-Treasurer*, 959 N. Seward, Hollywood 38, Calif.

The New York Section held a joint meeting with the National Television Film Council on March 11th at Farkas Films, Inc., New York City. "Operation Video Film—Better Film Quality for Television," was held in two sessions, at 4 and 7 p.m., in order to accommodate the audience of almost 600. It was another in the New York Section's series of how-to-do-it meetings.

During the meeting, a workshop demonstration on the proper scenery preparations, lighting adjustment and camera operation for film production to be used in television, was presented under the chairmanship of John Stott of Eastman Kodak Co.

A scene was staged, lighted and photographed at the Farkas Studios under the direction of a joint SMPTE-NTFC program committee. Nick Farkas made available the facilities of Farkas Films, Inc., in order that the two scenes to be photographed could be erected at his studios. Mr. Farkas acted as director of photography and Arthur Ornitz was the cameraman on the production. The local motion-picture production craft unions contributed their talent and cooperation to the program in order that actual working conditions could be maintained.

Television films must be produced within the boundaries of the technical characteristics of the television medium to achieve good visual reproduction. This production workshop demonstrated, explained and defined in detail, how these conditions can be achieved with particular emphasis on the term "white reference" and "black reference." Two scenes, one a living room and another a kitchen scene, were photographed and the lighting carefully measured both with a conventional photographic light meter and with a spot brightness meter. The meeting was informal in manner and the program committee led the description and discussion of the techniques used by Mr. Ornitz and his working crew to light the set for television film transmission. The enthusiastic capacity audience responded with a great many interesting questions.

The program committee is to be congratulated for taking on such a prodigious program requiring a great deal of coordination between production groups. The committee included Chairman John Stott, Eastman Kodak Co.; Peter Keane, Screen Gems, Inc.; John Whittaker, CBS-TV; and Nick Farkas, Farkas Films, Inc. It is planned that the prints resulting from this demonstration will be shown over a television system as the program for the April meeting.—Edward M. Warnecke, *Secretary-Treasurer*, Eastman Kodak Co., 342 Madison Ave., New York, N. Y.

The San Francisco Section's March 10th meeting was held at KGO-TV Studios in San Francisco. Twenty-two people attended. Joe Greer of Beckman-Whitley Corp., San Carlos, Calif., was the main speaker of the evening.

Discussing "Ultra High-Speed Photography," Mr. Greer divided the subject of high-speed framing cameras into four parts:

1. The principals of operation and methods used to obtain repetition rates up to 4.3 million per sec. (For complete technical description of operation, see the January 1959 *Journal*, pages 16–18.)
2. Methods and materials used in the manufacturing of Models 189 and 192 Cameras.
3. Applications and results: a series of 21 color 2 x 2-in. slides were shown of a charge blasting through a piece of 1-in. glass.
4. Methods of lighting, starting and synchronizing the events.

An informal discussion followed Mr. Greer's talk, during which it was learned that Beckman-Whitley has bought the rights to the Eastman Kodak high-speed 16mm motion-picture camera and will soon produce and market it under their own trade name. One of the new 250-frame, 16mm, portable framing cameras was on hand for the inspection by our members.—Frank Mansfield, *Secretary-Treasurer*, 57 Stoneyford Ave., San Francisco.

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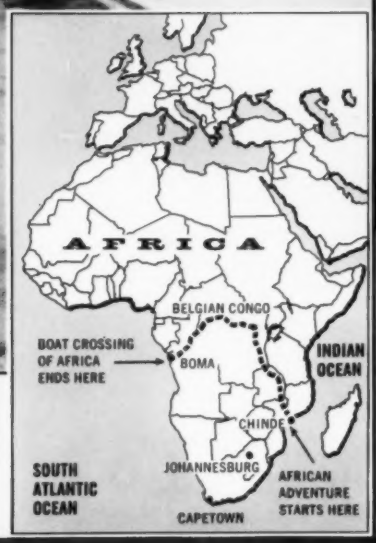

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New Members

The next *Directory for Members* is planned for April 1960. The following members have been added to the Society's rolls since the list published in Jan. 1959. Also listed are those regretfully reported as deceased since that date. The designations of grades are the same as those used in the *Directory*. An up-to-date list of the Sustaining Members appears on the outside back cover of each month's *Journal*.

Fellow (F) Active (M) Associate (A) Student (S)

Deceased

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Milton A. Bergstedt (M)
Hugo Bernzott (M)
David H. Ettenson (M)
H. H. Friend (F)
Thomas L. Gibson (M)
James H. Jeffares (M)
Frank W. Nelson (M)
Oscar A. Ross (M)
Ralph W. Rowe (M)
William M. Shortley (A)
Lt. Col. M. E. Williamson (M)

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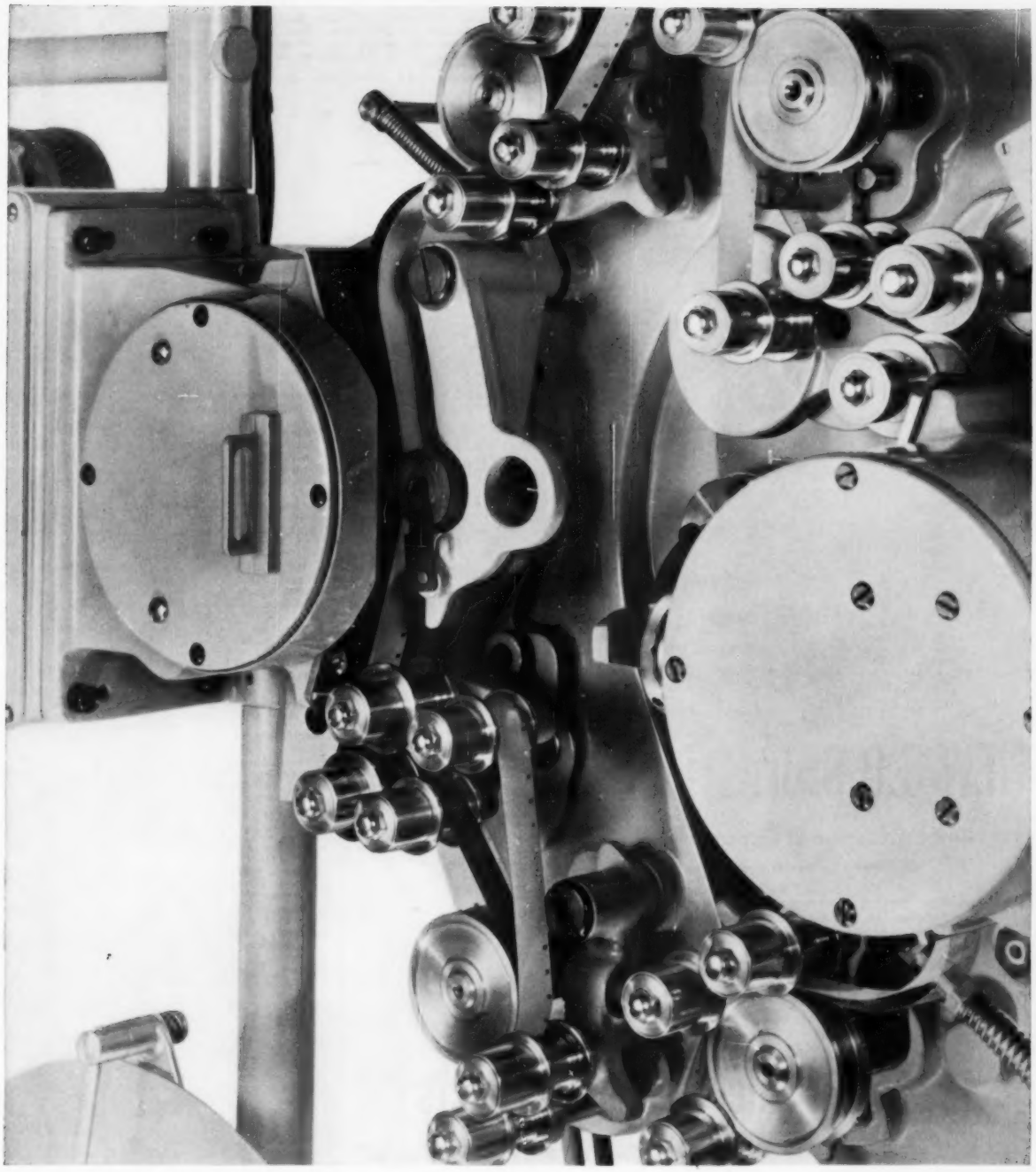

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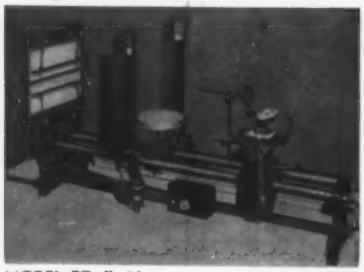

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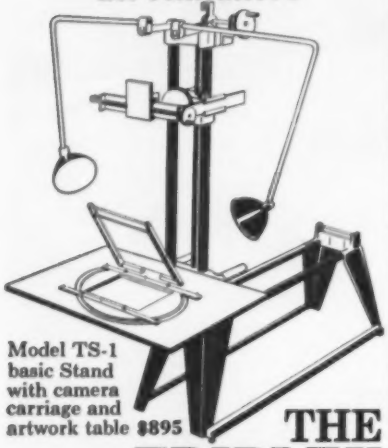

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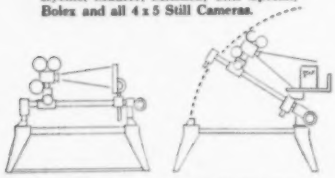

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Meeting Calendar

Biological Photographic Association, Midwestern Sectional Meeting, Apr. 24–26, Univ. of Iowa, Iowa City, Iowa.

American Physical Society, Apr. 30–May 2, Willard & Raleigh Hotels, Washington, D.C.

Electro-Chemical Society, 7th Annual Semiconductor Symposium, May 3–7, Sheraton Hotel, Philadelphia.

85th Semiannual Convention of the SMPTE including International Equipment Exhibit, May 4–8, 1959, Fontainebleau, Miami Beach.

IRE 7th Region Technical Conference and Trade Show, May 6–8, Univ. of New Mexico, Albuquerque, N.M.

Acoustical Society of America, May 14–16, Ottawa, Ont.

IEE, Transistors and Associated Semiconductor Devices, International Convention, May 21–27, Earls Court, London.

AFCEA National Convention and Exhibit, June 3–5, Sheraton-Park Hotel, Washington, D.C.

American Rocket Society, June 8–11, San Diego, Calif.

International Conference on Information Processing, June 15–20, UNESCO, Paris.

International Commission on Illumination, 14th Congress, June 15–24, Brussels, Belgium.

International Symposium on Circuit and Information Theory, June 16–18, Univ. of Calif., Los Angeles.

Engineering Progress Exposition, June 17–20, Hotel Commodore, New York.

American Physical Society, June 18–20, Milwaukee, Wis.

American Society for Testing Materials, Annual Meeting, June 21–26, Chalfont-Haddon Hall, Atlantic City, N.J.

Third National Convention on Military Electronics, June 29–July 1, Sheraton-Park Hotel, Washington, D.C.

WESCON, Aug. 18–21, Cow Palace, San Francisco.

National Symposium on Telemetering, Sept. 28–30, Civic Auditorium and Whitcomb Hotel, San Francisco.

86th Semiannual Convention of the SMPTE including Equipment Exhibit, Oct. 5–9, Statler-Hilton Hotel, New York.

IRE Canadian Convention, Oct. 7–9, Toronto, Ont.

National Electronics Conference, Oct. 12–14, Hotel Sherman, Chicago.

Society of Photographic Scientists and Engineers, Oct. 26–30, Edgewater Beach Hotel, Chicago.

Sixth National Symposium on Reliability and Quality Control, Jan. 11–13, 1960, Statler-Hilton Hotel, Washington, D.C.

IRE National Convention, Mar. 21–24, 1960, Coliseum and Waldorf-Astoria Hotel, New York.

87th Semiannual Convention of the SMPTE, May 1–7, 1960, Ambassador Hotel, Los Angeles.

88th Semiannual Convention of the SMPTE, and Fifth International High-Speed Congress and Equipment Exhibit, Oct. 16–22, 1960, Sheraton-Park Hotel, Washington, D.C.

89th Semiannual Convention of the SMPTE, Spring, 1961, Royal York, Toronto.

90th Semiannual Convention of the SMPTE, Oct. 15–20, 1961, New York.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members were published in the April 1958 Journal, Part II.

sustaining members

of the Society of Motion Picture and Television Engineers

The objectives of the Society are:

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
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